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NOTES AND COMMENTS.

Dust in the Foundry.

Various objectionable features in foundry operations have come under the notice of the authorities from time to time, and have been made subjects of restrictions and regulations. There is still much room for improvement, however, in many of our foundries, as, for example, in respect to the prevention and removal of dust; and while old-fashioned plants involve serious difficulty in dealing with the problem, modern foundries illustrate the vast improvement that can be made. When installing new plants or re-modelling and improving old plants, it is well to bear in mind the *desiderata* in the matter of dust. The summary, reproduced on another page, from a technical paper issued by the U.S. Bureau of Mines is worthy of attention, though local conditions would naturally dictate as to how far the suggestions could be followed.

It is suggested that castings should be cleaned and sand-blasted in a separate room, where only those men needed for the work should be allowed to remain, who should be required to wear respirators. Casting should be done in a separate building, where precautions should be taken to ensure ample ventilation by natural and artificial means. The main foundry room should be given more floor space, and, except where moulds are made, should have suitable flooring of steel plate or brick. The flooring should be sprinkled with water frequently. In addition, provision should be made for an abundant supply of fresh air. Grinding wheels should be supplied with an effective dust-exhaust system, and as an additional safeguard the men should be required to wear respirators.

All of these suggestions are in operation at some foundry or other with advantageous results, and some foundries have adopted the majority of the suggestions; but, taking foundries generally, the subject of dust prevention does not receive proper attention.

Fuel Economy.

Much has been written, and will continue to be written, on the important subject of fuel economy in metallurgical processes. Periodically we are presented with imposing arrays of figures and statements, attempting to illustrate that marked economies are being effected by one or another of the different systems of firing. At one time it is oil fuel which is to the front; then comes gas, high or low pressure; then some special method of coke firing or furnace construction. The statements made, however, must always be accepted with some reservation, particularly as regards the number of heats from a pot or a lining, and the fuel consumption. Such figures may be reliable if the author is the actual foundryman quoting from a run of normal daily practice; but if he is only a proprietor or general manager he may easily be misled. Most furnaces will give an efficiency much above their first month's average, both in fuel and

refractory life, when they are newly installed and carefully operated for test purposes; but this efficiency can seldom be maintained over a period of ordinary working. The furnaceman, asked what he is getting from a new furnace, is apt to overstate his actual results if he is anxious to please; or he may simply be told that the furnace will do so-and-so, and he must get the same results—and he does, or so the proprietor is given to understand. The furnaceman cannot be blamed, when he knows he will be considered incompetent if he cannot approximate to the theoretical figure given by optimistic makers.

Further, it is not uncommon to find the time required for the first couple of heats taken as the basis for a day's possible number of heats, the time required between for cleaning and making good being overlooked. The only real test for a furnace is the good work done over a fair period of actual working, taking into consideration the nature of metal melted, fuel consumption, life and cost of pots, labour required and quality of metal produced. Enthusiasts for fuel economy in both crucible and cupola working are apt to sacrifice the interests of good metal to fuel consumption, disregarding entirely the resulting scrap pile.

Recognition for the Foundryman.

Industrial workers have watched with considerable interest the distribution of the new Order of the British Empire, and much satisfaction has been expressed at the recognition of earnest endeavour in industrial as well as military and political activities; but we cannot trace any direct recognition having been given to the foundryman as such. It would be a well-earned tribute to a vastly important basic industry if such a compliment could be paid to a few representative foundrymen who have contributed well to the war's activities. It is not sufficient to select men of engineering or other industrial importance whose work embraces casually a foundry department, for most iron, steel and engineering magnates may be said to represent the foundry that far. What we want is recognition of the foundry as a distinct and important branch of essential industry. This would not only bring the trade better before the public notice, but would be a well-deserved tribute to a section which, working under unpleasant and obscure conditions, contributes highly skilled work on which most other branches of engineering depend.

Short Run Castings.

By "Moulder."

Most founders have the misfortune occasionally to lose a casting through an insufficiency of metal. With small castings this is not a serious matter, though even then it is undesirable, and is inexcusable on repetition work. The causes are numerous, and include:—Miscalculation of weight, unequal daubing of shanks and ladles, bad guessing, especially on intricate patterns, burst-outs, etc. A common method of estimating is to weigh the pattern if solid, the weight in pounds of a wood pattern being divided by 7 to get the result in cwts., deductions being made for cores, though if these are not bulky it is better to ignore them. This method has its limits, and when followed should be safeguarded by having a surplus of metal to compensate for error due to a dry and lighter pattern, while on the other hand the casting may be lighter than estimated, due to a denser wood having been employed in the making of the pattern, the dividing figure 7 being applicable to patterns made of pine. With reasonable care it is a very handy method, and on such jobs as it would be followed, it would be impracticable to calculate each one individually, while it is obvious that whatever method is followed, if the capacity of shanks and ladles is not known, due to unequal daubing, the results are uncertain.

The writer remembers three castings in one shop, and within a very short period, each weighing well over 10 tons, and each of which was lost through an insufficiency of metal. As these castings were of such a design as to offer no great difficulty in estimating the cubic contents of each, it would seem that the person responsible had been guilty of gross carelessness, especially seeing that it was not an unusual thing to cast jobs up to 25 tons, sometimes several in one week. The reason may have been miscalculation, or the lining of the ladle being too thick. To prevent similar occurrences, the terms "10-ton ladle," "20-ton ladle," etc., should be considered only as distinguishing one ladle from another, and not as representing a certain capacity. When estimating the weight of any casting, the number of cubic feet can easily be noted, and from this the volume to tap in the ladle obtained.

Assuming that the weight required to cast a job, with runner, risers, etc., be estimated at 12 tons, or 60 cub. ft. of metal, and a ladle be available nominally capable of holding 14 tons, it is worth while to calculate the actual capacity in cubic feet and not rely on the contents being 14 tons, as in example below:—

Diameter at bottom (inside) 4.0 feet.
" " top " 4.5 "
Vertical height to lip ... 4.5 "

If V = Volume in cub. ft.,
h = Vertical height in ft.,
a = Area at bottom in sq. ft.,
A = Area at top in sq. ft.,

Then $V = \frac{1}{3} h (a + \sqrt{a A} + A)$.

(The areas and sq. root required in example can readily be obtained by reference to tables or by the use of a slide rule.)

a = 12.56 sq. ft.
A = 15.9 s.q ft.

Then

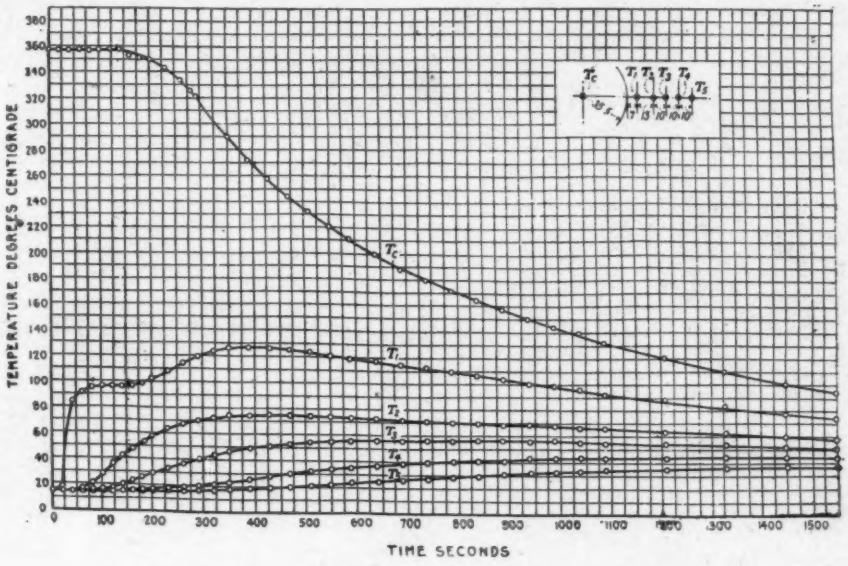
$$V = \frac{4.5}{3}(12.56 + \sqrt{12.56 \times 15.9} + 15.9) = 63.87 \text{ cub. ft.}$$

One ton of metal has a volume of about 5 cub. ft., so that the capacity of the ladle is short of 13 tons. The difference between the assumed capacity and the estimated capacity would easily be accounted for by the lining being 1 in. thicker around the sides, without taking into account the possibility of a thicker lining at the bottom.

Although the majority of moulders would not be able to estimate the weight of a complicated casting, there are occasionally one or two in a shop who could. It is not reasonable, however, to expect a moulder, with so many things to think about, to bother his head with the weight even if he is capable, and in any case he is not paid for doing it. The best plan, and one that can usually be carried out where heavy castings are made, is to have a large surplus of metal in case of a mishap, as a burst-out, which may occur anywhere, and have one or more moulds of lesser importance ready for any metal not used on the larger job.

Thermal Researches on Casting and Moulding Sand.

An investigation on the heat conductivity of moulding sand is described by Masatosi Okochi, in the "Journal of the Society of Mechanical Engineers," Tokyo, Japan. A wooden box 33 cm. square and 21 cm. deep was filled up with ordinary moulding sand. A cylindrical wooden pattern 7.1 cm. in diameter and 15.7 cm. in height was pressed into the sand to half its height at the centre of the box. Then molten lead having a temperature of 358 deg. Cent. was poured into the mould. Six thermometers were used. The first, nearest to the face of the mould, was a thermocouple, made necessary by the rapid rise of temperature as soon as the molten metal was poured in. The next five thermometers, located respectively at distances of 7 mm. for the first and 20 mm. for the second and equal intervals of 10 mm. for the rest, were of the mercury type. The moulding sand was ordinary river sand with a humidity equal to dry sand plus 10 per cent. by weight of water.



Curves of Flow of Heat in Moulding Sand.

Fig 1 shows data of one of the experiments. This indicates that T_1 rises rapidly as far as about 85 deg. Cent. and then rises very slowly until it reaches the maximum of 128 deg. Cent. A feature to which special attention is called is that the temperature remains stationary in the range of 96 to 98 deg Cent. This fact was observed in another experiment, and is ascribed to the influence of the humidity in the sand. According to the writer, the diminished rate of rise of temperature near the casting is maintained under 100 deg. Cent., because a certain fixed amount of heat flowing out of the casting is made use of in evaporating the water contained in the cylindrical layer of the sand between the thermometer and the casting.

In another test there was a very slight amount present, resulting in a temporary rapid rise of temperature. The writer investigates this phenomenon analytically by means of the theory of heat conductivity, and comes to the conclusion that castings will prematurely solidify, or, in other words, poured metal will not have sufficient fluidity if there is much humidity in the sand, even if the surface of the mould is thoroughly dried.

The Institute of Metals.

The annual autumn meeting of the Institute of Metals was held on Wednesday, September 19, in the rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. At the opening session, between the hours of 4 p.m. and 6.30 p.m., the following communications were presented:—

"Experiments on the Fatigue of Brasses," by Mr. B. Parker Haigh;

"Hardness and Hardening," by Professor T. Turner;

"The Effects of Heat at Various Temperatures on the Rate of Softening of Cold-rolled Aluminium Sheet," by Professor H. C. H. Carpenter and Mr. L. Taverner;

Note on "A Comparison Screen for Brass," by Mr. O. W. Ellis.

At the evening session, from 8 p.m. to 10 p.m., the programme will be as follows:—

"Further Notes on a High Temperature Thermostat," by Mr. J. L. Haughton and Mr. D. Hanson;

"Principles and Methods of a New System of Gas-Firing," by Mr. A. C. Ionides;

"Fuel Economy Possibilities in Brass-melting Furnaces," by Mr. L. C. Harvey;

"The Effect of Great Hydrostatic Pressure on the Physical Properties of Metals," by Professor Zay Jeffries;

Note on "The Use of Chromic Acid and Hydrogen Peroxide as an Etching Agent," by Mr. S. W. Miller.

Some of the above-mentioned papers are reproduced in abstract in this issue.

Making an 80-Ton Casting Under Difficulties.

A notable engineering feat has just been performed by Messrs. Ruston, Proctor & Company, Limited, Lincoln. By the courtesy of this famous and progressive firm, we have been able to obtain some details of the achievement. Its interesting feature does not lay principally in the making of castings of big weights—although we believe them to be the heaviest made in Lincolnshire—but rather in the difficulties encountered in making them in a foundry not designed for such work.

Owing to the increasing demands made upon their output it had become necessary to further extend the plant, and, in connection therewith, very heavy castings of 60 and 80 tons—which the firm decided must be made in one piece—were required. Urgent requirements demanded that these should be made quickly, and the railway companies' refusal to carry such weights threw the firm entirely on its own resources. After every difficulty had been carefully considered the firm decided to make the castings themselves, and as close to their final destination as possible.

A mere résumé of the difficulties is of interest. In the first place, though large in area, Ruston's foundry is equipped with cupolas and cranes only to suit the medium-sized work which is usually required. Secondly, the roof of the foundry, being built in pre-modern days, was very low, and the height from floor to hook of crane not more than 12 ft. Again, the maximum power of any single crane in the shop was only 20 tons, and, to complicate matters, the river runs along the end of the foundry, and the average water level is just 2 ft. below the shop level.

The pattern for the larger block was a mere skeleton, just large and definite enough to give the moulders the shape of the outside. After the mould had been dried in the oven and finished up to dimensions, it had to be removed to a position as low down in the floor as possible, for the reasons: (1) That the sides might be rammed up and made strong; and, secondly, that sufficient head room might be obtained for the cranes to lift the ladles high enough to pour. The mould was sunk into a pit—a hole roughly 20 ft. sq. and 10 ft. deep—and at this point we would remind the reader that 2 ft. below floor level was water, as shown by the man, thigh-deep in water on left-hand side of casting in Fig 2.

FIG. 1.—MOULD FOR 80-TON CASTING READY FOR POURING.

At least 50 tons of molten metal was needed before the casting operation could be commenced. This metal was obtained from three cupolas and run into ladles of different sizes. Our first photograph shows the operation about to take place. This first operation was but the prelude to not only the pouring in of all the 80 tons required, but also to the feeding (all through the night) of the molten metal, and this "feeding metal" was obtained from a fourth cupola. The process lasted, in all, 16 hours. Then a week elapsed before anything further could be done, or before any part could be exposed, the slow cooling being essential to keep the mass free from contraction strains. Fig. 2 shows the coping and binders removed and the

casting turned on its side to allow of it being "fettled" and the cores taken out.

To move the casting from its bed involved considerable difficulty, more apparent when it is remembered that each crane had but a lifting power of 20 tons, and the casting itself weighed 80 tons. To get over the difficulty two cranes were connected together, *i.e.*, a heavy girder was slung between the two cranes, and supported at the ends by forgings in place of the usual hook, whilst adequate safeguards were applied to prevent any accident. This gave sufficient power to lift one end of the block at a time, and so on to a roller track constructed from railway metals with a unique application of the ball-bearing principle for transit. From the point shown it was removed 500 ft., and thence to its site.

Tests of Silica Bricks.

MESSRS. C. E. NESBITT and M. L. BELL recently read a Paper before the American Society for Testing Materials, from which the subjoined extracts are taken:—

In actual service silica bricks fail from three primary causes: spalling, crushing and slagging. With a view to studying the effect of degree of fineness of material and pressure on their strength an experimental series of silica bricks was made with these two factors as the only variables. A good quality of Pennsylvania ganister was selected and ground dry in three lots to pass a 12, 8 and 4-mesh screen respectively. To the ground material was then added 9 per cent. of water and 2 per cent. of lime. From each of the above meshes standard 9-in. bricks were made on a hydraulic press at eight different pressures varying from 187 to 2,500 lbs. per sq. in. The bricks were dried, burned and cooled, following regular silica-brick practice, and were then subjected to certain physical tests to determine density, resistance to impact, resistance to spall, resistance to corrosive action of slag and expansion due to heating. A summary of the results is given in Table I., in which the results of the three meshes are averaged according to pressure used in making the bricks.

TABLE I.—*Tests of Silica Bricks, according to Pressures.*

Pressure Lbs. per sq. in.	Apparent specific gravity.	Impact. In.	Percentage spalled.	Slag penetration, sq. in.		Expansion, inches per ft.
				Open-hearth slag.	Heating furnace slag.	
187	1.50	47	45.5	3.48	2.28	0.155
500	1.58	46	48.3	3.68	2.42	0.155
750	1.59	60	53.2	3.63	2.41	0.158
1000	1.63	65	51.4	3.79	2.42	0.160
1250	1.65	68	47.9	3.65	2.50	0.155
1500	1.66	65	43.6	3.82	2.50	0.160
2000	1.67	67	44.8	3.64	2.45	0.159
2500	1.68	71	42.0	3.72	2.50	0.160

TABLE II.—*Tests of Silica Bricks, according to Mesh.*

Mesh.	Apparent specific gravity.	Impact. In.	Percentage spalled.	Slag penetration, sq. in.		Expansion, inches per ft.
				Open-hearth slag.	Heating furnace slag.	
4	1.66	57	30.4	3.92	2.63	0.156
8	1.62	63	47.6	3.67	2.39	0.159
12	1.58	64	63.2	3.44	2.29	0.159

Table I. proves that little is gained by increasing the pressure in making bricks. Table II., however, shows the importance of the mesh. It will be observed that the strength as indicated by the impact test is greatest with the fine ground material, while the percentage loss by spalling increases with fineness of mesh. Two very important properties in first-class silica bricks are mechanical strength and resistance to spalling; hence we must select a mesh at the expense of one of these two desirable properties. More is gained by the coarse mesh, hence the authors advocate for silica bricks a coarse-ground material.

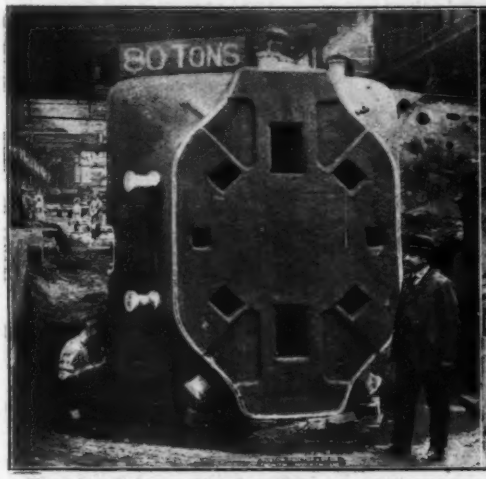


FIG. 2.—CASTING FETTLED READY FOR TURNING OVER.

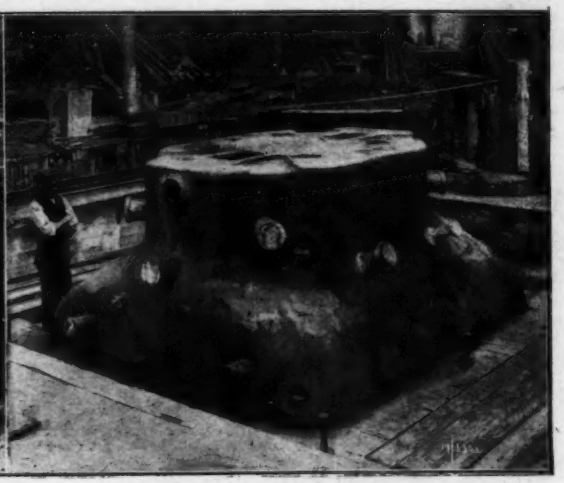


FIG. 3.—CASTING IN POSITION.

The average spalling loss for hand-made silica bricks is about 30 per cent. From Table III., giving the losses by spalling for each pressure and mesh, it will be noted that power-pressed silica

TABLE III.—*Percentages of Spalling Losses.*

Mesh.	Pressure under which bricks were made, lbs. per sq. in.							
	187	500	750	1000	1250	1500	2000	2500
4	21.9	34.9	37.9	38.7	31.4	30.4	19.1	29.1
8	51.6	45.9	62.6	51.0	43.3	34.8	38.3	43.3
12	62.9	64.0	59.2	64.4	69.1	65.8	67.0	53.6

bricks were made with the same spalling loss from 4-mesh material pressed at 1,500 lbs. per sq. in. These bricks were true to shape, sharp-cornered, dense, and had smooth, marble-like surfaces. Moulding defects such as soft corners, sponginess, improper slicking, and lack of cohesion were all eliminated. The prospect of the adoption of power pressing as a step towards better and more uniform silica bricks was clearly brought out by this series of tests. The idea is not entirely new, yet little has been done in a commercial way. One of the large concerns is now manufacturing bricks this way on a commercial basis. The average spalling loss of these bricks is 25 per cent.

STEEL CASTINGS (GILES FOUNDRY), LIMITED, are being wound up voluntarily, with Mr. H. Darville, Phœnix Foundry, Swan Village, West Bromwich, as liquidator.

Fused Bauxite for Furnaces.

M. N. Lecesne, in a recent issue of "La Céramique," describes the following method of preparing bauxite for furnace lining and crucibles. A mixture is prepared of one part of anthracite and three parts of bauxite of average composition (about 60 per cent. of alumina, 10 per cent. of iron sesquioxide and 10 per cent. of silica), in the state of moisture in which it comes from the quarry. The mass is charged into a furnace lined with refractory material (preferably fused bauxite), and previously heated up with anthracite, air being blown through the charge at an initial pressure of about 40-in. water gauge, rising afterwards, according to the depth of the charge, though 160 in. of pressure is the usual maximum. The temperature rises quickly and the sudden vaporising of the water in the bauxite causes the latter to break up and to granulate, while the aluminium carbide which is produced burns and raises the charge to a point at which the silica is volatilised and the iron, reduced by the action, is expelled by the air blast as a shower of sparks. The air blast is continued, to burn off the surplus anthracite and cool down the fused mass, which can then be discharged from the furnace and ground, mixed with crude or calcined bauxite as a binder, moulded, dried, and fired in the same way as calcined bauxite. If the fusing is performed quickly, say in about three hours, the resulting mass will be highly porous, besides containing a sufficiency of unconsumed anthracite to facilitate grinding and briquetting. The fused bauxite will give a refractory material stated to be capable of withstanding a temperature of over 2,000 deg. C. if mixed with some of the same material freed from iron by magnetic separation, and with water and quicklime, the latter forming a binder of silicate of lime.

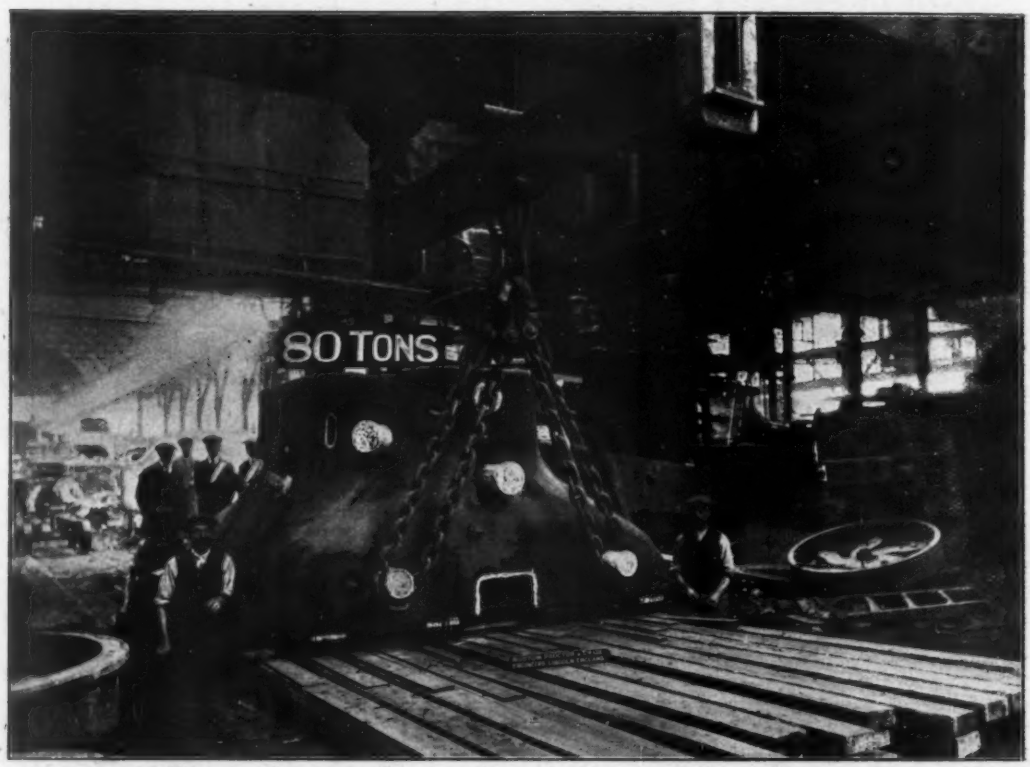


FIG. 4.—METHOD OF ROLLING 80-TON CASTING TO ITS FINAL DESTINATION.

Moulding Fly Wheels.—I.

By Joseph Horner.

Figs. 1 to 7 show the usual sections employed for the rims of fly wheels. Each one entails some modification in the methods of moulding, and especially so when the moulds are made from sectional patterns, or by sweeping, and with cores, more than when full patterns are used.

If the periphery of a rim is straight across as in Figs. 1 and 2, the sand joint can be made along the top edge of the rim. But if it is curved as in Figs. 3 to 5, it must be jointed around the central plane of the rim; and in any case, the inner

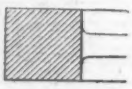


FIG. 1.

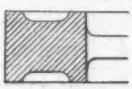


FIG. 2.

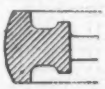


FIG. 3.

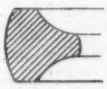


FIG. 4.

FIG. 5.

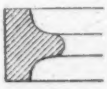


FIG. 6.

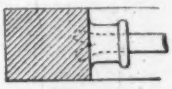


FIG. 7.

joint must coincide with the central plane of the arms. This does not entail making a joint through the pattern, which is seldom done, since that would seriously reduce the strength of the pattern arms, and because their elliptical section is entirely favourable to their delivery on the lifting-off of the top-part box. Further, a full pattern is not necessary if the method of pattern-plating for plate moulding is adopted, when one-half suffices, but if not, the pattern must be complete like its casting. The reason why a half only is sufficient, Fig. 8, when a plate is used, is that one-half the wheel is an exact replica of the other, so that if two half-

FIG. 10.

FIG. 8.

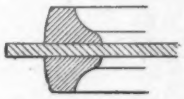


FIG. 9.

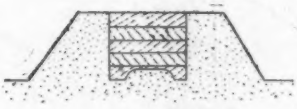


FIG. 11.

moulds are taken they will, when closed, make the complete wheel mould. The drag or bottom part is rammed first and rolled over, along with the pattern plate cottered to it, and laid on the foundry floor in its location for pouring. The plate and pattern are then withdrawn, and the top part is rammed on them. Being then put in its place on the bottom, the pouring basin is made round the runner pins.

Pouring is usually done through the boss in small wheels, but in the larger wheels with heavy rims it is done both through rim and boss. As an alternative to Fig. 8, top and bottom boxes are rammed on opposite sides of one plate, Fig. 9, each box receiving a separate half pattern. Even if a full pattern is made but not mounted permanently on a board it will become rammed out of truth unless it is laid upon a joint board during ramming; excepting much time is spent and thus wasted in levelling it up, and making the joints round the arms previous to the actual work of ramming the bottom-part box.

It is open to question whether much advantage is gained by substituting the aid of a moulding machine for hand work in these wheels, provided the methods of mounting shown in Figs. 8 and 9 are adopted. The mould parts are shallow, and the delivery is good. Advantage would only lie with those machines in which hand ramming can be saved by the employment of a presser head. Stripping plates are not required, and the moulds are too shallow for satisfactory jar-ramming.

Full patterns are not usually made for large

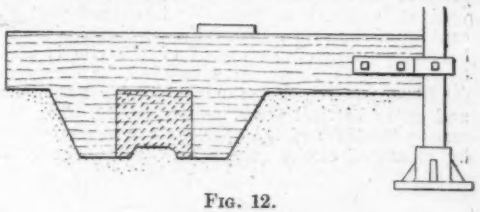


FIG. 12.

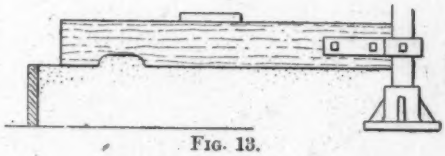


FIG. 13.

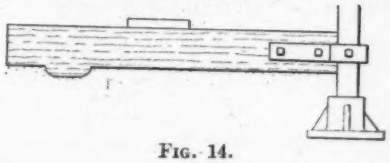


FIG. 14.

wheels, or those, say, over about 4 ft in diameter; first, because they are moulded satisfactorily by another method, and second, because the cost of patterns bears too large a proportion to that of the limited numbers of the large castings that are called for. Another reason sometimes exists in the practice of building up the largest wheels in separate castings. In these, a pattern arm is made, and a pattern segment, comprising a sixth, eighth,

or tenth portion of the rim, and a boss, and the parts are united with bolts, cottars, and bonds.

The larger fly wheels cast solidly are made without full patterns by a composite method of moulding, variations in the details of which occur with differences in the sectional shapes of the interior of the rim. The simplest form is that of a section which is mainly rectangular as in Figs. 1 and 2. These are less troublesome than those in the subsequent illustrations, the reason for which will be seen directly.

For dealing with the sections Figs. 1 or 2, two

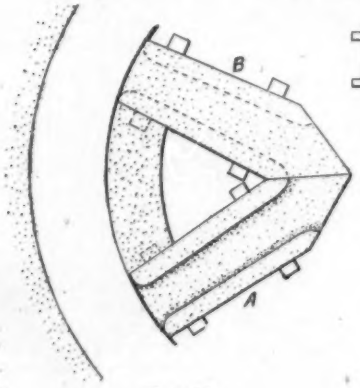


Fig. 15.

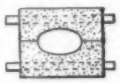


Fig. 16.

methods are open to choice. In one a segmental piece of pattern is prepared, Fig. 10, of any convenient length, but preferably to extend past the centres of the arms. From this sectional piece the bottom portion of the mould of the rim is made by working it round on a levelled, hard-rammed sand bed, and ramming the mould against the inner and outer vertical faces, as in Fig. 11. The successive locations of the segment are accurately set by means of circles struck on the sand bed. In the second method the circles are struck directly from the sweeping board, Fig. 12, which board also forms two sloping walls between which and the pattern segment the sand is rammed. The bed is both levelled and swept by the board in Fig. 12, and on it the section of the rim may be drawn as shown, as an exact guide to the moulder.

Before describing the method of the formation of the arm moulds, the top part or cope may be considered. This can be made in either one of two ways, being either swept directly with a board cut as in Fig. 13, or rammed on a false mould, using a board cut as in Fig. 14, with which the dummy mould is swept.

In the first case the top box is laid on its back and thus rammed, and its face is swept with the board, Fig. 13, and this box when turned over covers the bottom mould previously rammed round the sweep. But in Fig. 14 the board does not sweep the actual cope mould, but the hard-rammed bed of sand on which subsequently the top is rammed. The top is easily lifted off it without suffering damage, provided a good thickness of parting sand is strewn over the face previous to the ramming. This ramming of the cope must, of course, be done before the lower bed is swept, and the bottom mould rammed. After the top has been rammed the sand is dug out and removed, and the bed is swept to form the lower mould with the board in Fig. 12.

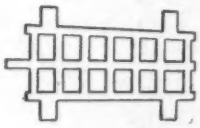


Fig. 17.

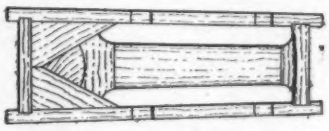


Fig. 18.

The advantage which the latter method offers over the other is that the top part goes back exactly into its original position guided by the stakes with which it has been set during the ramming. In the other case, having been swept elsewhere than on its own lower mould, it has to be set over this by measurement alone.

The arms are made in cores. Differences will be noticed in the designs adopted in Figs. 1 and 2 and in Figs. 4 to 6. In the first, the interior of the rim being plain, it is formed by the direct ramming of the sand against the interior as in Figs. 11 and 12. In the second examples this cannot be done, because the sectional form prevents delivery. In the first cases, therefore, the cores need only include the arms, but in the second they must in addition impart the shape to the whole interior of the rim.

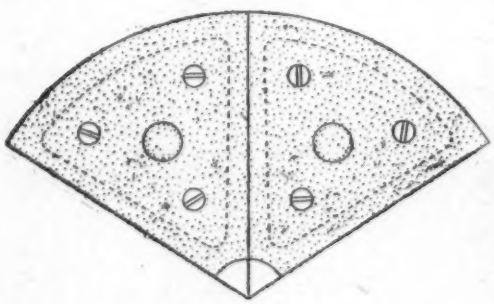


Fig. 19.

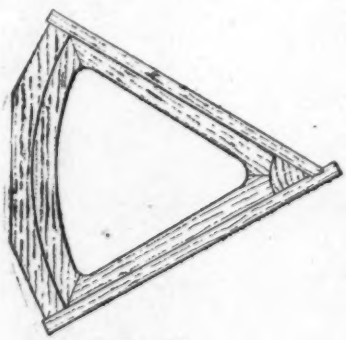


Fig. 20.

In Fig. 15 two arm cores are shown in their relation to the rim, which cores are rammed in the box in Fig. 16, suitable for the wheel rims in Figs. 1 and 2. Each arm is formed in two half-cores, jointed in the horizontal plane. The lower half only of such a core is seen exposed at A, Fig. 15, but at B the view is taken on top of the

two cores. They are each rammed on a grid, Fig. 17, which is supported in recesses during the ramming, cut in the box sides, seen in Fig. 16. A cross section taken through the two cores and their grids is seen in Fig. 18. These cores coincide with the interior of the rim mould at one end, and abut against each other next the boss. The space between the cores next the rim is occupied by sand previously rammed against the pattern segment, a portion being cut away to permit of laying the arm cores in. Alternatively instead of ramming the inner edge of the rim it is formed wholly with cores, the spaces between the arm cores being

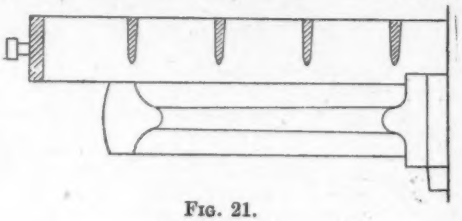


FIG. 21.

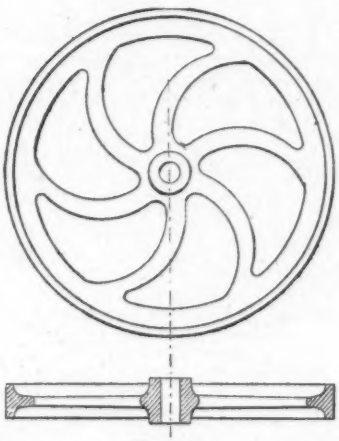


FIG. 22.

occupied with segmental dried cores made in a box and laid in position.

In the second example, in which the interior of the rim is of an ogee section, as in Figs. 4 to 6, the shape is formed by the arm cores wholly. These are not jointed in the horizontal plane. They have vertical abutting joints, Fig. 19, and fill up the whole of the interior enclosed by the wheel rim. The shape of the core box, Fig. 20, and its shading will enable its method of construction to be understood. The cores shown in Fig. 19 are each rammed on a grid of triangular shape, with three eyes used for lifting the core. The central area is filled with cinders to receive the vents which collect there, and escape through the central hole out into the top. The vertical section, Fig. 21, indicates the relations of the parts of the mould.

Fly wheels that have curved arms, Fig. 22, cast solidly with rim and boss, are not so easily made with cores as those with straight arms are, because the curvatures involve such awkward shapes in the boxes. The larger the wheels are the less trouble is entailed, because the spaces are larger. In general it is better in these designs to use a set of cast-iron pattern arms distinct from the rim, which may be of wood. A complete wooden pattern with straight arms is flimsy, because of the lap joints which are made at the centre, and which can only be partially reinforced by the screwing on of the bosses. One with curved arms is even more flimsy, since in addition to the weakening caused by the lap joints there is that due to the shortness of grain in the curved portions near the rim. For these reasons a cheap pattern should be constructed in timber, and a set of metal arms cast from it, to which the bosses can be attached with central studs. If a complete pattern in wood is used it must either be divided and attached to opposite faces of

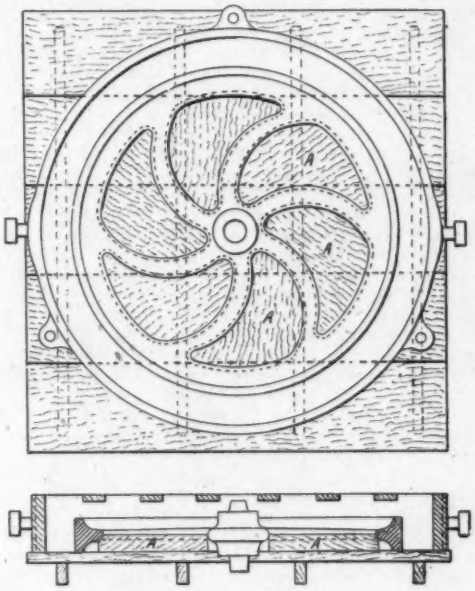


FIG. 23.

a pattern plate, or it should be rammed on a joint board.

When a common bottom or joint board is used, Fig. 23, support is afforded to the rim by the face of the board, and to the arms by making-up pieces, A, which are fitted between the arms, and to a little distance underneath them—sufficiently far to afford the necessary support to them against the ramming. These blocks also provide the joint face to the central plane of the arms, and thus avoid the need of making a sand joint around them by hand work at each time of moulding. These blocks need not be fitted very nicely, provided they make a reasonably close contact with the arms. They are screwed upon the bottom board.

The drawing, Fig. 23, shows only the first stage of the preparation for the moulding. The bottom box part is laid over the pattern as shown, its pins entering holes bored in the joint board. The joint of the mould outside the rim will, therefore, be made on the face of the board there. After turning over, the top part mould will extend from that face down within the rim to the sand face made by the blocking pieces, A, along the central plane of the arms.

The Acid Open-Hearth Process.*

By F. Rogers, D. Eng., B.A. M.Sc. (Sheffield).

Whilst numerous writers have dealt with the general metallurgy of the acid open-hearth amongst the other steel-making processes, they have, on the whole, left room for a reasonable claim that persistent mystery and some ignorance continually enshroud steel-making, especially by the acid open-hearth and crucible processes. Many of the views and suggestions in the present Paper will have a direct or indirect bearing upon steel-making by all the six usual processes, but attention has been centred upon the acid open-hearth process, partly for the reason mentioned, and also because for a considerable period of years acid open-hearth steel has remained in this country a sort of standard of reference for quality amongst structural steels. Further, the metallurgy of this process offers in many respects a convenient starting point for the study of all the steel-melting processes. In all the oxidising processes it is essential at the end to deoxidise the metal by some means. The prime effect of neglect to do so is blowholes in the ingot, a defect which in the majority of cases is inadmissible. There is also considerable evidence which suggests, but as yet does not prove beyond doubt, that beside the gases (mainly oxygen in some form and hydrogen and nitrogen) which cause blowholes, further gas, including oxygen, remains in combination or solution in the steel, to its detriment.

Two principal methods are in use which contribute to secure the desired end. The first is the bringing of the bath to proper "condition" towards the end of the melting process; this factor assumes exceptional importance in the open-hearth acid process. The second is the use of deoxidisers. The term "condition" is often abused in its application to steel-melting, being used in a vague and mysterious manner, frequently to cloak ignorance. It is true that it is not yet possible to keep the working under the continuous control of instantaneous precise measurement, but there is every reason why this fundamentally important "condition" should be as fully understood as possible. What is meant by "the condition of the bath" is properly its temperature, the composition (particularly the carbon and oxygen contents) of the metal, and the composition (particularly the iron oxide content) of the slag. There are many considerations involved in judging the "condition" during working. After the primary aim, the adjustment of the carbon content, is well in hand, the deoxidation of the metal should occupy first place. The diminution of oxygen in the metal is indicated by the appearance of the sample and by the quieting down of the reaction, in conjunction with the carbon content of the metal, the composition of the original charge and slag so far as known, and the temperature.

"Dead melting" means the minimising of oxygen in the metal at this stage. The influence of temperature in dead melting in usually misunderstood. The reaction between iron oxide and carbon in the bath proceeds further in the direction of minimising the total iron oxide present, as the temperature is raised. On the other hand, the rate of oxidation of the bath by the furnace atmosphere increases with the temperature. In practice, however, under ordinary conditions, the author has found that the balance is strongly in favour of the higher temperature. No satisfactory figure for the temperature can be given, since the means of measurement hitherto available are always open to an error of 20 deg. to 30 deg. C., and this amount is sufficient to make the difference between good dead melting and bad.

Fig. 1 illustrates this point. It has already been mentioned that it is important to minimise the small amount of oxygen which remains in the metal. The foregoing remarks, however, would apply equally well if we were merely contemplating the minimising of oxygen in the slag, but in some of the following remarks this would not apply, and it may therefore be taken that the author considers oxygen as being present in the bath (and in the solid steel) in small amounts as dissolved iron oxide. The bearing of these views, however, is less clear unless it be realised that he considers that when dead melting is achieved, there is an appropriate equilibrium involving the retention of an amount of iron oxide in solution, in the molten metal, which is quite a definite amount in relation to the other factors involved (temperature, carbon principally, in presence of iron, silica principally). The equilibrium here referred to is not a stationary condition, but the reaction still continues, in passing through this condition.

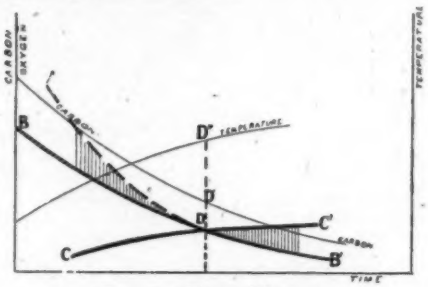


FIG. 1.—DEAD MELTING.

Curve "Carbon" shows the bath carbon content (C) in relation to the time (t)
" "Temperature" shows the corresponding temperatures.
" BB' shows the oxygen (O) taking part in the reaction FeO + C = Fe + CO; the equation of the curve is $O = -\frac{16}{12}\frac{dC}{dt}$
" CC' shows the oxygen entering the slag from the atmosphere. CC' and BB' intersect at D.
" AD shows the total oxygen present in the bath previous to D. The curve AD frequently meets BB' elsewhere than at D.

The part of the ordinate intersected between BB' and ADC' represents the oxygen in the bath in excess of that taking part in the reaction FeO + C = Fe + CO. These intercepts are plotted separately in Fig. 2.

The ideal consists in dead melting to "condition D," that is:
Oxygen D, ALL in course of removal by reaction FeO + C;
Carbon D';
Temperature D'.

The influence of lime (if present) in this equilibrium, should here again be mentioned for the sake of completeness. The addition of lime causes in effect the displacement of some iron oxide (although the entire slag remains an approximately homogeneous solution) which reacts with carbon in the metal, thus lessening the total iron oxide in the system. The effect is slightly increased because the distribution of iron oxide between slag and metal will (upon well-understood physical and chemical grounds) be proportioned to the total iron oxide present—that is, the addition of lime does not merely lessen the iron oxide in the slag, but also

* Read before the Iron and Steel Institute.

lessens the iron oxide in the metal correspondingly. The diagram represents this :—

Effect of Adding Lime.

$$\frac{FeO - SiO_2}{FeO - C} \quad \text{Slag} \quad \frac{\left.\begin{matrix}CaO\\FeO\end{matrix}\right\} - SiO_2}{FeO - C} \quad \text{Metal}$$

Before adding lime. After adding lime.

It is evident from this explanation of the action of lime that when, as often happens, the nature of the charge and other conditions are such that the early addition of lime is not essential, it is sufficient to add lime at a late stage, in approaching the dead melted condition. The above-described reaction then occurs, and a satisfactory dead-melted condition is attained in from twenty to sixty minutes, according to various other circumstances. In this way the exposure of the banks to possible damage from careless handling of the lime is minimised.

It is necessary, in considering the above, to realise that the whole process is an oxidising one, and that the oxidising action never ceases during normal working. Thus the expression "dead melting" is a relative one, and it is important to inquire what happens if the "dead-melted" condition be over-stepped in any way. At this stage the reaction may be comparatively slight—for example, a drop of 0.01 per cent. carbon in ½ hour—

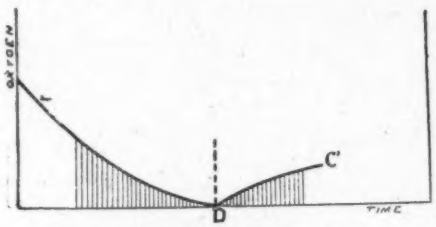


FIG. 2.—DEAD MELTING.

The ordinates are oxygen in excess of that taking part in the reaction FeO+C=Fe+CO, as obtained from, and explained under Fig. 1.

or rapid—a drop of three to five times as much—yet with satisfactory results. Reference to Fig. 1. will show what may happen next: we may in the extreme case have the rate of production of iron oxide by furnace atmospheric oxidation greater than the rate of its decomposition by carbon, and the carbon being low, the metal becomes increasingly charged with iron oxide. It is probable that the solubility of iron oxide in the metal increases slightly as the temperature rises and as the carbon decreases beyond some very low figure (Fig. 4).

It is further probable that the solubility of each of the gases decreases continuously with rise of temperature from the melting point, but drops suddenly in solidifying, as shown qualitatively in Fig. 4 for oxygen as CO. Reference to Fig 2 will now show in a simple form one of the principal features extracted from Fig. 1, namely, the curve of excess oxygen present—the oxygen in the bath as a whole which is in excess of what can be removed by the reaction with carbon.

In Fig. 3 the corresponding complete diagrams (such as Fig. 1) for two different temperature curves are given, with summary of several of the most important effects of adopting the higher temperature curve.

We can now see the several conflicting factors which enter into the proper deoxidation at this stage—the chances of underdoing it on the one hand, and leaving the steel considerably oxidised, though not markedly wild (this is the commonest error), or, on the other hand, overdoing it and producing wild steel, which is not in all circumstances fully cured by the use of deoxidisers. Thus, for

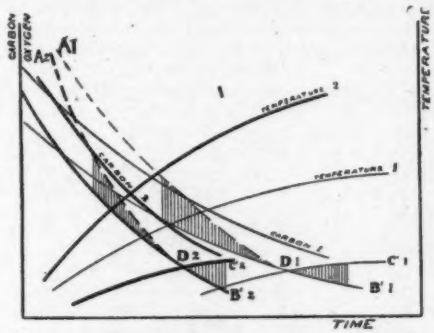


FIG. 3.—DEAD MELTING. INFLUENCE OF TEMPERATURE.

Two diagrams of the type of Fig. 1. are here obtained for the two different temperature curves 1 and 2. The other corresponding curves are marked throughout respectively 1 and 2. Otherwise the notation is as in Fig. 1. D1 and D2 are the two resulting ideal dead-melting "conditions." The advantages of the higher temperature curve 2 are seen to be: Greater speed of working; greater probability of reaching "condition D" at all; greater definiteness of "condition D," &c., as discussed in the text.

example, it is useless to make a rigid practice (as the author has known done) of running the carbon down to 0.07-0.09 per cent. in all casts, with practically no reference to "condition" in other respects, and then to imagine that this is dead melting because a lot of "pigging-back" was done. At 0.09 per cent. carbon the bath is usually "underdone," because a relatively high temperature is required to dead-melt at this carbon.

Incidentally, a relatively slight excess of tempera-

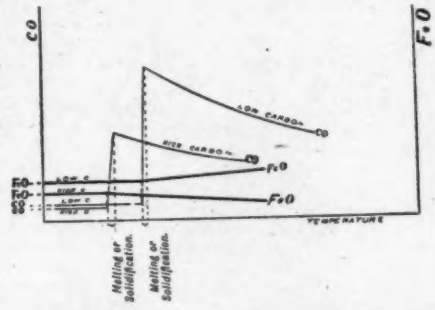


FIG. 4.—SOLUBILITY OF CARBON MONOXIDE AND OF FERROUS OXIDE.

ture would, under these circumstances, lead to wildness; but with care in approaching 0.09 per cent. carbon there is no difficulty in obtaining a good dead-melted condition at this carbon if necessary. Another extreme instance is the attempt to catch the carbon at, say, 0.45 per cent. carbon,

including obtaining three or four successive samples in ½ to 1½ hours, all analysing 0.45 per cent. carbon. This can be done, and sometimes is—approximately—but it is not to be imagined that this is properly "dead-melting." The bath has in such a case been held quiescent by its coldness, and the diagrams show that, under these circumstances, its oxygen content is higher than it should be before going on with the additions. Incidentally, a relatively great excess of temperature, and even a first addition of lime, need not in this instance do worse than cause the fall of the carbon to from 0.25 per cent. to 0.30 per cent. in 1 to 1½ hours and produce a good dead-melted bath.

It will be realised that to a great extent the diagrams here presented must be only of a qualitative nature. They have, however, been derived from a great variety of experiments arranged to test the various points at issue. It will be seen, for example, that a consequence of Fig. 1, as of some of the above-expressed conclusions, would be, that if the temperature of the bath could be promptly raised whilst keeping the other conditions (especially oxidation and carbon addition) as stationary as possible, an underdone cast could be dead-melted or a dead-melted cast made wild. This is not, however, very well illustrated in the acid furnace, owing to the relative slowness of the heating, but the action is evidently exactly what should be made fullest possible use of, as mentioned in the foregoing instances. On the other hand, it is possible to study this action in the reverse way—that is, by prompt cooling of the bath. The means by which the author achieved this was the addition of fairly massive scrap steel of similar class to the bath. If this be done when an ideal dead-melted condition has been obtained, then as soon as the scrap addition is melted and mixed in, the bath shows the usual signs of coldness. Again, if a good dead-melted condition be exceeded, and by pushing the temperature too high in relation to the other conditions a somewhat wild bath is obtained, the addition of the correct amount of scrap restores a perfect dead-melted condition.

Here the author feels obliged to issue a word of warning. It must not be imagined that he is advocating the indiscriminate addition of scrap for the control of condition in dead melting; to do so might cause more mischief than it would remove. Further, he does not make a sweeping claim of novelty in adding scrap (or anything else) to the bath, which has often been done by others, especially amongst the final additions; but he is not aware that it has been used in exactly the way above described in the study of the essential "condition" of the bath. It is one of the most valuable methods of study of which the author is aware, and it has assisted him in arriving at a decision as regards several of the more obscure features of the subject.

It is necessary to draw attention to another important consequence of the above views. In the attempt to end the oxidising stage satisfactorily, it is from the practical point of view necessary not only to minimise the oxygen present in the system, but also to do so with the carbon content within reasonable limits of a desired figure—which varies considerably with the circumstances. The nature of the running equilibrium has been indicated, and it is therefore evident that some careful choice must be exercised in regard to the controllable excesses which may occur. In this respect we have to notice chiefly temperature, carbon, and iron oxide. The influence of temperature has already been discussed. The important point as regards carbon and iron oxide is to choose correctly the carbon content at which to cease oreing, so that in view of all the particular circumstances then prevailing (approximate ore content of the bath, the relative keenness of working of the furnace, the general nature and volume of the slag, etc.) dead melting will be achieved at a convenient carbon content.

Deoxidisers.

It may be, and sometimes is, asked: What is the advantage of such great care in deoxidising the bath by dead melting when deoxidising additions are afterwards to be used? The reply is that the author has found by wide and careful experiments that no one deoxidiser will alone thoroughly deoxidise steel, and that when two or more deoxidisers are used, each has an effect, and the combined effect is greater than if one of them be omitted; in fact, the more the better, if they be good oxidisers. The fact that carbon alone is not sufficient to deoxidise steel demonstrates the truth of this conclusion. The actions of the deoxidisers are not quite identical. Thus we have carbon, which forms a gaseous product (CO, possibly soluble in the metal, but largely passing off) with the oxygen present, and a soluble carbide with the metal.

Manganese, to the extent it is commonly used, dissolves in the metal in some form and produces manganese oxide, which unites with avidity with silicates, but which is at most slightly soluble in the metal. Incidentally also, a part of the manganese unites with sulphur, producing an insoluble sulphide. The action of silicon normally resembles that of manganese—it is partly dissolved in some form, and it produces insoluble silica, whose assimilation by the silicates and basic oxides is not so ready as the combination of MnO with the silicates. Aluminium, in the amounts used, enters only to a very slight extent into the metal, and produces an oxide which frees itself fairly readily from the metal, but which does not readily associate itself with the other non-metallic matters. From the point of view of partial pressures of solutions and balanced reactions, the greater simultaneous action of deoxidisers seems fairly comprehensible. Despite, for example, the presence of some manganese in solution in the molten metal, a certain amount of FeO and CO still remain dissolved and even unacted upon by Mn.

Upon adding silicon to the system, the saturation pressures of FeO and CO fall still further, but not to zero. There is similarly a drop upon each deoxidising addition, assuming that at least a slight excess of deoxidiser is used.

Temperature Effect.

The exact saturation pressure of the residual FeO and CO depend upon the temperature. The heat balance shows that in the presence of excess deoxidiser the pressures will fall with higher temperature. This the author has verified in numerous experiments. In other words, *the deoxidisers are more efficacious the higher the temperature of the metal at the time of their addition.* The effect of higher temperature and time in giving the entangled products greater opportunities to float to the top is generally recognised. Here, again, high temperature is advantageous, but it is, as in dead melting, necessary to beware of the renewal of too oxidising conditions in attempts to raise the temperature at this stage. The casting conditions which have to be met are, however, usually permitted to dictate the tempera-

ture control more and more as the end of the process is approached. Throughout, the process is admittedly full of such compromises, but the present is a plea for ideals accompanied by suggestions as to how to attain them, and even in the last-mentioned stage, the author much prefers to see it attempted to get the maximum deoxidation as stated, followed by temperature control, or even by modification in the details of casting, to obtain the required ingots.

Casting.

Approaching the casting stage, the processes have more and more in common, but at the same time there is a greater variety in any event in the conditions to be met, in the size and form of ingot, etc., so that strictly metallurgical generalisations are not so readily applicable to the whole field. Only a few of these points will be touched upon in the present Paper whose relation to the melting process proper is closest, and other features will be left until a future occasion. Much good steel is more or less ruined in " the pit " in casting, and the author has given much importance to the improvement of execution at this stage. Three of the principal types of original defects in steel are rokes, non-metallic inclusions, and pipe. Rokes which do not contain siliceous matter may arise in mechanical ways in worked steel, but more generally they arise from blowholes in the ingot. The means which have above been outlined for minimising oxygen are the prime means for obviating rokes arising from blowholes. Blowholes, usually local in the ingot (that is, not related to the general anatomy of the ingot) can also arise through wrong design of ingot, bad surface or facing of mould, etc.

Non-metallic inclusions arise in various ways: (1) Entangled slag, and silicates or MnS in suspension in the bath and carried over to the ingot; (2) silicates formed *in situ* in the ingot by a continuance of the deoxidising action and aided by oxidation of the steel by air during its passage into the mould; (3) MnS formed *in situ* by continuance of the action of Mn in the ingot during solidification; (4) fluxed refractory fittings, especially runner bricks. The influence of high temperature and time in lessening (1) has already been noted. As regards (2) and (3), there is a slight advantage in hot steel; (4) is a strong argument for avoiding bottom running if possible.

Steel made on the lines indicated will have the greatest tendency to piping, but it is always possible to minimise this tendency systematically. This depends essentially upon the adoption of conditions conducive to efficient feeding during solidification. These include the proper proportioning of diameter to length of ingot and means of hindering the cooling of the upper part; these means are of several kinds, and their choice largely depends on cost in relation to the selling value of the steel. Refractory lined heads, and ingots wide end uppermost, are the simplest and most direct methods. The full advantages of casting ingots wide end up are, for the greater range of ordinary work, best obtained from a mould standing on a loose bottom plate, preferably with a well for sizes over 3 tons or so, containing a loose but fairly massive piece of scrap plate for the stream to strike upon first. If this loose piece be adopted, *it is essential that every loose piece absolutely should be identified afterwards for each ingot*, since sometimes I have known this plate, if too light, to be washed up into the ingot and cause trouble.

Conclusions.

In conclusion, the main objects of the present Paper have been to give critical consideration to the principal features of the acid open-hearth process which affect the production of a sound, clean ingot. Naturally, attention has been mainly centred upon the most predominant of the features, deoxidation. The means of carrying these principles into effect in the process have been indicated —ideal dead melting and the proper use of lime and of deoxidisers. Finally, brief consideration has been given to conditions which must be observed in order to utilise the full advantage of the high degree of deoxidation obtained, and in order to minimise the piping to which such steel is otherwise subject. It is seen that the author's general preference is for ingots top cast, with the wide end uppermost, and suitably fed, as for example, by refractory heads, or special methods.

Experiments contributing to the conclusions here recorded have been made in many works. The author is thus indebted to many firms, and is grateful for courteous permission to mention amongst them Messrs. Cammell Laird & Company, Limited, Sheffield; Messrs. Taylor Bros. & Company, Limited, Leeds; and Messrs. John Baker & Company, Limited, Kilnhurst, near Sheffield.

EFFICIENCY OF AIR COMPRESSORS. — Mr. H. E. MacCamy, in a recent thesis on air-compressor efficiency, states that there is only one condition under which a compressor can be worked whereby it can furnish the number of cubic feet of air which it was designed to produce, and this condition is the elimination of the moisture from the air. The usual way to effect this is to establish auxiliary receivers near the end of the line in which to condense and precipitate the water; but the water should have been removed from the air before it entered the high-pressure cylinder, or at least 90 per cent. of it. The power wasted in compressing steam in the high-pressure cylinder would be saved, and the oil used to lubricate the high-pressure cylinder would do its work instead of being carbonised. This carbon sediment finds its way through the receiver and pipe lines into the tools, requiring the user to soak them in kerosene or naphtha. Even the back pressure, so often found in the low-pressure cylinder, causing the low-pressure side of the compressor to give more trouble than the high-pressure side, is attributable to moisture. The reason for this is that the ratio of the cylinders is such that the high-pressure cylinder cannot receive the expanded air from the low-pressure cylinder when the intercooler fails to reduce the temperature of the air (about 300 deg.) coming from the low-pressure to 60 degr. or lower. With the ordinary intercooler, when the compressor has been working at its maximum for 1 or 2 hours, the temperature of the air entering the high-pressure cylinder will be about 125 deg., and the gauge will show from 25 to 30 lbs. pressure; but if the temperature could be lowered to, and maintained at, 60 deg., the gauge will show a pressure of 3 to 5 lbs. less. The increased volume of useful air that would be received from the compressor, if all the water vapour could be removed from the air before it enters the high-pressure cylinder, would be the volume of steam generated from the 46.67 cub. in. of water contained in 1,000 cub. ft. of saturated air, at the point of condensation. It is apparent that the efficiency of a multiple-stage compressor can only be calculated by the amount of water removed from the air in its passage through the intercooler.

The Heat Treatment of Grey Cast-Iron.*

By J. E. Hurst (Acton, London).

PART I.

In a somewhat extended study of the properties of cast-iron for internal-combustion engine cylinders, the question of the behaviour of this material when subjected to the influence of heat has been given considerable attention. The rapid deterioration of cast-iron cylinder components—the liner, piston and valve chambers—is a subject of vital importance to the internal-combustion engine manufacturer. It is proposed in these notes to deal with the question of the behaviour of cast-iron when subjected to heat, only in so far as it is concerned with the deterioration of the above-mentioned parts.

TABLE I.

Sample No.	Analyses. Combined carbon per cent.	Graphite, per cent.	Total carbon, per cent.	Silicon, per cent.	Manganese, per cent	Sulphur, per cent.	Phosphorus, per cent.	Position.
2 (*a*)	0.15	3.49	3.64	1.60	0.63	—	0.134	From inner portion of head exposed to heat (direct).
2 (*b*)	0.55	3.14	3.69	1.86	0.45	0.064	0.162	From outer portion of head away from heat.
2 (*c*)	0.19	3.10	3.29	2.10	0.64	—	0.123	From gudgeon pin boss far removed from heat.
5 (*a*)	0.05	3.22	3.27	1.91	0.68	—	0.122	As above. (2*a*)
5 (*b*)	0.19	3.03	3.22	2.05	0.74	0.055	0.121	,, (2*b*)
5 (*c*)	0.19	3.13	3.32	1.93	0.68	—	0.120	,, (2*c*)

The temperature which the centre of the cast-iron piston heads of Diesel engines sustain during working is undoubtedly very high. In many cases the "star cracks" produced in them after short periods of use can be traced to mechanical defects, such as bad design, defective cooling arrangements, etc., which tend under the influence of heat to set up unequal stresses in the material, extremely liable to bring about fracture. It has been shown that the strength of grey cast-iron rapidly falls off with increasing temperatures, and it will be readily appreciated that the influence of unequal stresses due to mechanical or other defects under the conditions obtaining in the Diesel engine cylinder will be considerably more pronounced.

The series of analyses recorded in Table I. are taken as indicated in the table from various positions in cracked Diesel engine pistons. The only change indicated by these analyses is that of the condition of the carbon content—the combined carbon being practically wholly converted into free or graphitic carbon. From an examination of the figures there would appear to be no indication of oxidation of the carbon or silicon contents as was experienced by Carpenter and Rugan in their well-known investigations on the growth of cast-iron. In fact, in piston No. 1 there is a decided excess of total carbon in the portions exposed to the action of the heat over that in the portions well removed from its influence. This state of affairs probably existed in the original casting.

* Abstract of Paper read before the Iron and Steel Institute.

It was attempted to determine "oxidised silicon" in each of these samples by the method briefly outlined by Rugan and Carpenter. Samples of the turnings were powdered and placed in flasks fitted with Bunsen valves. The turnings were covered with a large excess of cold dilute hydrochloric acid and allowed to stand for forty-eight hours. In no case was there any "micro-crystalline grey residue" obtained, and the final precipitate of silicon was quite white and flocculent.

A series of analyses given in Table II. show the effect of heat treatment on the condition of the carbon content on a series of grey cast-iron bars. The samples, the dimensions of which were 2 in. by 1¼ in. by ¾ in., were heated for the stated periods of time in an open iron tube, and quenched in water at the room temperature. At a temperature of 750 deg. C. it will be seen that practically the whole of the combined carbon is rapidly converted into the free carbon form. All these samples were effectively quenched in water, and it will be noted that slow cooling is not a necessary factor in the dissociation of the pearlite in grey cast-iron. Also it would appear that temperature between the limits of 750 deg. C. and 900 deg. C. has little influence on the rate of decomposition, nor does there appear to be any influence exerted by the varying phosphorus content.

TABLE II.

Mark on specimen.	Combined carbon, per cent.	Graphite, per cent.	Total carbon, per cent.	Silicon, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Remarks.
P1	0.50	3.35	3.85	1.87	0.834	0.005	0.016	Original samples.
P2	0.50	3.51	4.01	1.79	0.742	0.005	0.106	
P3	0.47	3.17	3.64	1.87	0.776	0.005	0.43	
P4	0.44	3.08	3.52	1.89	0.44	0.05	0.85	
P1. 1	—	3.72	3.85	Not estimated				750° C. for 2 hours. Quenched in water.
P2. 1	—	3.62	4.01					
P3 1	—	3.33	3.64					
P4. 1	—	3.29	3.52					
P1. 2	—	3.85	3.85	Not estimated				750° C. for 4 hours. Quenched in water.
P2. 2	—	3.96	4.01					
P3. 2	—	3.61	3.64					
P4. 2	—	3.53	3.52					
P1. 3	—	3.73	3.85	Not estimated				900° C. for 2 hours. Quenched in water.
P2. 3	—	3.63	4.01					
P3. 3	—	3.50	3.64					
P4. 3	—	3.51	3.52					

Similar samples of grey cast-iron were heated to a temperature between 900 deg. and 950 deg. C. for varying periods of time in an open iron tube. The samples were each withdrawn after having been heated for the requisite length of time and quenched in water. The change in condition of the carbon content is illustrated by the analyses in Table III., from which it will be seen that a portion of the free carbon has been reabsorbed. It is very probable that the reabsorption of the free carbon has reached its maximum for the temperature of the experiment in Sample 3, the high free carbon content in Sample 4 being ascribed to ineffective quenching. There is a very noticeable increase in hardness in these specimens, Sample 3 being perfectly glass hard. This reabsorption of free carbon is most important, both from a practical and theoretical point of view. It will be

noted that this experiment has been performed on a sample of high-phosphorus cast-iron. Further experiments have been made on a complete set of varying phosphorus cast-irons with a view to studying this phenomenon in greater detail. It is intended to make these the subject of Part II. of this Paper.

TABLE III.

Specimen.	Duration of heating.	Combined carbon per cent.	Graphite, per cent.	Total carbon combustion, per cent.	Silicon, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.
Original metal	—	0.38	2.91	3.30	2.39	0.64	—	1.19
(1)	5 mins.	—	2.69	—	—	—	—	—
(2)	15 ,,	—	2.31	—	—	—	—	—
(3)	30 ,,	—	1.64	3.38	—	—	—	1.15
(4)	45 ,,	—	2.66	—	—	—	—	1.13

Influence of Phosphorus.

It has been found, as a result of long experience, that the ultimate cracking of engine piston tops (apart from those cases of mechanically defective pistons) can as a general rule be traced to the phosphorus content of the cast-iron. A typical analysis of an actual cast-iron piston is as follows:—Combined carbon, 0.78 per cent.; graphite, 2.60 per cent.; total carbon, 3.53 per cent.; silicon, 1.92 per cent.; sulphur, 0.144 per cent.; phosphorus, 1.08 per cent. Cast-iron pistons of this type almost invariably crack after actual use in the Diesel engine. By the reduction of the phosphorus content of the cast-iron to the lowest possible limits the life of the pistons was considerably prolonged and the troublesome cracking practically eliminated.

Discussion.

DR. CARPENTER said the Paper dealt with a very important subject too briefly, so that he welcomed the author's statement that another Paper on the same subject might be expected from him. The author stated that, on the whole, the greatest enemy to cast-iron as a material for the construction of Diesel engine pistons was phosphorus, and that many difficulties in connection with cracking had been removed by reducing the phosphorus to what the author called the lowest possible limits. That was a very interesting and important statement, and he should like to know what was the percentage of phosphorus that the author recommended as fulfilling that condition. The author also said that he considered the piston-head might reach a temperature of at least 900 to 950 deg. C. The melting point of the phosphide eutectic was 953 deg., and it therefore appeared that, if that statement was right, and the 950 deg. was reached, probably the main cause of the cracking of a Diesel engine piston when the phosphorus was high was due to the actual melting of the material. He should like to ask whether that figure of 900 to 950 deg. C. was experimentally determined, or was—to put it bluntly—merely a guess. There was no doubt that much higher temperatures were reached in the Diesel engine. Another important point mentioned in the Paper was the question of the change in the condition of the carbon. The author stated—and he could bear the statement out from his own work on the subject—that there was no doubt the condition of the carbon changed. Under certain conditions carbon might be precipitated, and under certain other conditions it might be re-absorbed. That would result as a consequence in certain volume changes in the material, which would set up stresses, and under the severe conditions the piston had to stand it was not surprising that fracture should occur also owing to that cause. That difficulty would be always present as long as grey cast-iron was used.

MR. E. ADAMSON said the author spoke of the growth of cast-iron. He himself was inclined to think there was a certain amount of stretch before the growth commenced. A little further on there was a reference to temperatures of 750 to 900 deg. C. There were so many differences in the tests published, and in the results obtained in connection with cast-iron, that it was necessary to know all the conditions before any conclusion could be reached. With regard to re-absorption, that was a very interesting point, but he was disposed to think that another explanation of the apparent absorption at increasing temperatures was, that when cast-iron was chilled at any given temperature stresses were set up which might be apt to make the iron attach to itself a particle of carbon, and produce carbon in solid solution. The quantity taken up in solid solution would depend upon the temperature at which the cast-iron was quenched, and he thought that that would explain perhaps the idea of the carbon being absorbed as the temperature of the iron went up.

MR. H. J. YOUNG said the author remarked that no influence was exerted by the varying phosphorus content, but by the way the Paper finished up one would think that the author had proved that there was. After heating his specimens, the author withdrew them and quenched them. If a specimen of cast-iron was heated and cooled naturally, and heated again and cooled again, perhaps for forty times a very different effect was obtained from that which would be obtained if it were only heated and quenched once. Table III. did not give the sulphur, which was a very important part of the cast-iron, and the combined carbon mentioned was determined by colour. He believed it was well known that the colour test for combined carbon was of no value for works use. From the size of the specimens the analytical results given in the Paper could not be taken as absolutely reliable.

SAFE LIMIT OF CARBON DIOXIDE IN THE WORKING ATMOSPHERE.—Prof. G. O. Higley, of the Ohio Wesleyan University, in a Paper on the safe limit of carbon dioxide in the working atmosphere, read before the American Public Health Association in October last, stated that the conclusions of investigators seem to be that (1) one may breathe for several hours air containing 20 times the usual permissible per cent. of carbon dioxide without perceptible deleterious influence upon one's health; (2) that stagnant air containing 2 to 15 times the generally accepted amount of carbon dioxide may be respired seven hours per day for five or more weeks with no perceptible effect upon heart rate, on increase of heart rate on standing, on blood pressure, Crampton value, or respiration of the subject; (3) that all the deleterious effects that were formerly attributed to respiring carbon dioxide present in stagnant air may be produced by breathing for the same period air that is practically free from carbon dioxide, but which has a temperature of, say, 90 deg. Fah., and a very high relative humidity; (4) that a cold, dry air when heated to 80 deg. Fah. or more without humidification may produce, when respired for some time, deleterious results. Prof. Higley concluded by asserting that in view of the fact that recent investigations have apparently shown carbon dioxide to be harmless when respired in much larger amounts than 0.08 per cent., the safe limit of this gas in the working atmosphere should be placed at 0.2 per cent.

Fuel Economy Possibilities in Brass-Melting Furnaces.*

By L. C. Harvey (London).

Fuel economy is a very engrossing proposition. Let us consider, first of all, the amount of coal mined in the world for one year, and the possible extent of the wastage of that year's supply of coal. For 1910 the amount was about 1,300 million tons, and it is improbable that anything like 5 per cent. of this fuel was ever turned into actual useful work. This means that 1,235 million tons of coal were mined only to be wasted in heat radiation and other losses: this represents enough fuel to melt and superheat 25 million tons of brass to 10 per cent. above its melting temperature. Until petroleum becomes available in large quantities, and its price is brought down to reasonable limits, the only fuel to consider is coal. This should be used as mined, in the furnaces direct, or in gas-producers adjacent to the furnaces. The costly process of coking is only a means to obtain a clean, smokeless fuel, of intense heat value, at the expense of considerable wastage.

Considerable quantities of copper, brass, bronze, heavy plate, stern tube liners, propellers, and other products are melted in reverberatory furnaces, chiefly for the reason that heavy castings are required; but these furnaces consume several times the amount of fuel that would be used to melt the same amount of metal in crucibles. Reverberatory furnaces are therefore greater fuel wasters even than crucible furnaces, which are themselves extremely inefficient. The amount of metal melted and the weight of fuel used in reverberatory furnaces, however, have not been taken into account in this Paper, so that the estimates to be given refer only to crucible melting plants. It is impossible to give exact figures for the output of metals melted in crucibles under the present conditions, but it can be definitely accepted that whereas the assumed figure for the quantity of brass melted in this country during 1916 is one that probably falls short of the real collective output of the brass foundry trade, the deductions arrived at in regard to fuel used are under-estimations.

Though much thought has been expended during recent years upon the equipment of coal-consuming plants with more efficient types of boilers, fuel economisers, mechanical stokers, feed-water heaters, etc., with the ultimate end of saving fuel, in the brass foundry it is still the general practice to melt metals in small uneconomical coke-fired crucible furnaces of the pit type, having heat efficiencies of only 2 to 6 per cent. Assuming, for sake of argument, that the output of brass for the above mentioned purpose rose to 2,000,000 tons in 1916 for Great Britain alone, the amount of coke required to melt this quantity of metal in small pit furnaces of 5 per cent. heat efficiency would have been 800,000 tons. This presupposes that the coke has a calorific value of 12,960 B.T.U. per lb., and that 261 B.T.U. are required to melt brass of a 70 : 30 mixture and to superheat the alloy to 10 per cent. above its melting point. In other words, the total amount of heat imparted to the metal would be 1,169,280 million B.T.U., representing 41,714 tons of coke, which means that the balance of 758,286 tons of coke would be wasted in radiation and flue losses. This amount of wasted fuel at 35s. per ton would represent £1,327,000, and the total amount of 800,000 tons £1,400,000. The relatively large capacity crucible tilting furnace had fortunately been developed during the last 13 years, and large plants of this type have been put down, so that, taking into consideration the tilting furnaces existing prior to

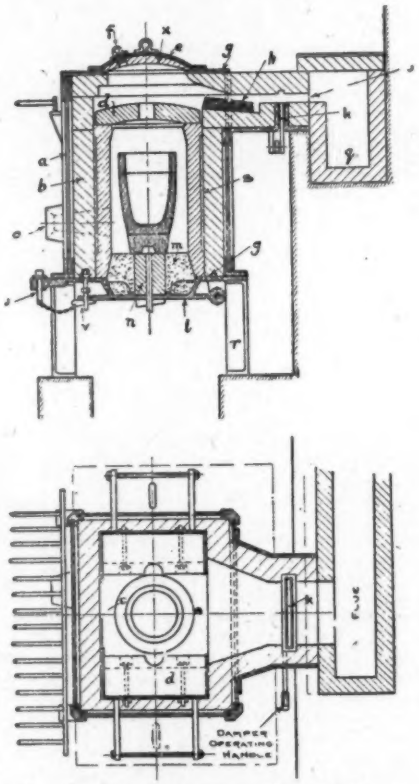


FIG. 1.—SECTIONAL ELEVATION AND PLAN OF SPECIAL PIT FURNACE SHOWING PREHEATER HEARTH.

Essential reference letters: *a*, External panels of sheet iron or expanded metal. *b*. External lining. *c*. Internal lining. *d*. Melting-chamber cover. *h*. Pre-heating hearth. *k*. Flue damper. *l*. Drop bottom for supporting *m*, refractory nodules, and *n*, crucible support. *o*. Oil or gas burner attachment. *s*. Cavity between linings.

August, 1914, together with the new plants put down since, it can be accepted that of the quantity of brass mentioned—2,000,000 tons for 1916—about one-third was melted in tilting furnaces. Now the average all-round working heat efficiency of the coke-fired crucible tilting furnace on 70 : 30 brass is about 15 per cent. If, therefore, the whole of

* Abstract of Paper read before the Institute of Metals, September, 1917.

the 2,000,000 tons of metal had been melted in tilting furnaces, the amount of fuel used would have been reduced to, say, 266,666 tons of coke, of which the heat value of 41,714 tons would have been imparted to the metal and that of 224,952 tons wasted in furnace and flue losses. In money this would mean £393,666 spent on wasted fuel in tilting furnaces as against £1,327,000 in pit furnaces. On the assumption that 2,000,000 tons of brass were cast in 1916, of which one-third was melted in tilting furnaces, these plants were

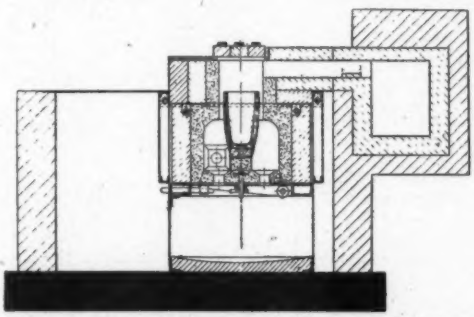


FIG. 2.—SECTIONAL VIEW OF MULTIPLE-CRUCIBLE FURNACE FOR OIL, GAS OR POWDERED COAL.

responsible for saving the nation approximately 178,000 tons of coke, having a total value of £311,500. This, however, is not the whole story, for the coke used in melting furnaces has to be made from coal, in which process there is more wastage. Gases and volatile constituents in coal which could be utilised in the melting chambers of furnaces are lost in the coke ovens.

That "foundry" coke is necessary for cupola work is undisputable; but this high-grade fuel for brass melting is not essential if systems can be improved so that coal can be used direct instead of having first to be converted into coke. This can be done in two ways, by the use of:—(*a*) Powdered coal; (*b*) unscrubbed producer-gas.

The first system is the ideal one, resulting in no loss of heat prior to burning in the furnace. The second method is a convenient one where large plants are concerned, but it is not so readily applicable to the small foundry, and in any case there are producer losses which are absent in the first system. These losses, however, probably counterbalance the energy required to grind coal to the powdered state. Powdered coal can be applied and burnt as readily as liquid fuel or gas, and it has many of the important advantages of these fuels in so far as running costs for crucibles, linings, labour, etc., are concerned. It is well known that these costs are much below those for coke-fired furnaces. Referring again to the figures mentioned above, for the 2,000,000 tons of brass, if melted in pit furnaces, 800,000 tons of "foundry" coke were required. This would mean about 1,143,000 tons of coal, of which approximately 1,083,265 tons of coal would be mined only to be wasted in radiation and flue losses. On the other hand, if crucible tilting furnaces had been used entirely, the overall amount of coal burnt as powdered coal, leaving the efficiency of the furnace still at 15 per cent., would have been approximately the same as the figure given for coke, viz., 266,666 tons, or a saving of 733,334 tons of coal for 1916. A very small amount of this gross saving of fuel would have been used in supplying air under a slight pressure for burning the powdered coal. This, again, is still allowing for a relatively low furnace efficiency of 15 per cent., but it is inconceivable that heat efficiencies of crucible melting furnaces cannot be raised to 30 and 40 per cent. by careful study and application of improved methods of combustion and utilisation of the heat carried off in the waste gases.

During the past three or four years town gas has been successfully employed in crucible melting furnaces from the standpoint of cleanliness, convenience, and especially life of crucibles, viewed from which this system has many important claims. But as a fuel economiser it has none. The overall working efficiency of small gas-fired pit-type crucible furnaces is approximately the same as for the larger tilting type, i.e., 15 per cent. Assuming the calorific value of town gas to be 550 B.T.U. per cub. ft., then 2,126 million cub. ft.

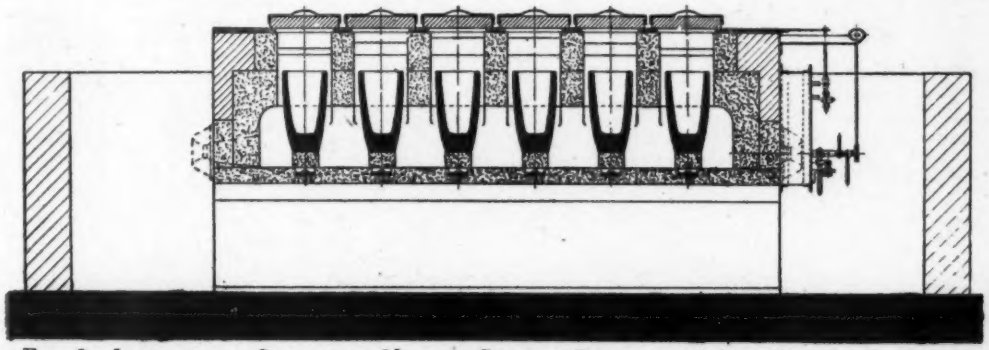


FIG. 3.—LONGITUDINAL SECTION OF MULTIPLE-CRUCIBLE FURNACE FOR OIL, GAS OR POWDERED COAL.

of gas would be required to melt and superheat the 2,000,000 tons of brass. In pit furnaces and tilting furnaces the total amount of gas burnt for this quantity of brass would have been 14,336 million cub. ft. Assuming 1 ton to yield 12,000 cub. ft. of gas, this would mean approximately for either the pit furnace or tilting furnace 177,166 tons used for useful purpose and for the production of 106,000 tons gas coke, and

1,194,666 tons of coal wasted in heat radiation and flue losses, and the production of 717,000 tons of gas coke. It will therefore be seen that, apart from leakage in the gas mains, pit furnaces and tilting furnaces take a maximum quantity of 1,371,832 tons of coal as gas; 1,143,000 tons of coal as coke (800,000 tons of coke), at a value of, say, £1,143,000; or £1,400,000 as coke. On the other hand, tilting furnaces would take 380,951 tons of coal as coke (266,666 tons of coke), at a value of £380,951, as against 1,371,832 tons of coal for making gas (60 per cent. gas-coke production would equal 823,300 tons of this by-product, which can be re-used in gas-producers). These costs, however, bear a more striking significance if they are considered in relation to the usual charge for gas at prices charged for town supply. Say this is 2s. per 1,000 cub. ft., then the cost alone for melting the 2,000,000 tons of brass would be £1,433,600. The suggestion therefore arises that gas, if used, must be produced upon the site, and this brings us to the second proposition mentioned—producer-gas.

Producer-gas cannot be economically generated for very small plants, but for the larger capacity melting furnaces, even when only one or two units are installed, the producer-gas system presents a very convenient arrangement. Assuming, for sake of argument, that producer-gas had been used for melting the 2,000,000 tons of brass, the following figures show the approximate costs of this system.

and 50 per cent. in cost of fuel when using producer-gas instead of town gas.

As regards fuel oil, this was quoted recently at 160s. per ton, but in order to be comparable with the other fuels its cost will be assumed to be 80s. a ton. The heat efficiencies of single crucible pit furnaces and tilting furnaces are about 5 per cent. and 14 per cent. respectively. At 19,700 B.T.U. per lb. of oil, pit furnaces will require 530,000 tons costing £2,120,000, and tilting furnaces 200,000 tons costing £800,000. The great bulk of this quantity would have to be imported, and with pit furnaces 503,503 tons, and in the case of tilting furnaces 175,503 tons of the fuel would have to be shipped to this country only to be converted into heat to be dissipated in radiation and flue losses. These figures refer to the melting of brass alone, and do not include the fuel used for melting the large quantities of iron, steel, aluminium, special alloys, cupro-nickel, etc., that are melted in crucibles. For convenience of comparison the quantities of fuel and their costs, and also the heat efficiencies of furnaces for different kinds of fuel, are given in Table I.

As the efficiency of the present-day pit furnace is so very low it becomes more than ever necessary to see whether the design cannot be improved. With this end in view the author suggested a furnace as shown in Figs. 1 and 2. The lining must be thick, in order to reduce the amount of heat radia-

TABLE I.—*Relative Quantities of Coal used in Various Types of Crucible Furnaces.*

Type of Furnace	Pit Furnace.	Tilting Furnace.	Tilting Furnace.	Single Crucible Pit Furnace or Tilting Furnace.	Multiple Crucible Pit Furnace, or Single Crucible Tilting Furnace.	Pit Furnace.	Tilting Furnace.
Fuel	Coke	Coke	Powdered coal	Town gas	Producer-gas	Oil	Oil
Heat efficiency	5 per cent.	15 per cent.	15 per cent.	15 per cent.	10 per cent.	5 per cent.	14 per cent
Tons, or c. ft. of fuel used for an output of 2,000,000 tons of brass	800,000	266,666	...	14,336 million c. ft.	...	530,000	200,000
B.T.U. value per lb. or c. ft.	12,960	12,960	12,960	550	135	19,700	19,700
Tons, or c. ft. of fuel used to useful purpose net	41,714	41,714	41,714	2,126 million c. ft.	8,661 million c. ft.	26,497	26,497
Tons, or c. ft. wasted in losses net	758,286	224,952	224,952	12,210 „ „	89,600 „ „	503,503	173,503
Coal Values (Coke and Gas in Terms of Coal).							
Tons of coal used gross	1,143,000	380,951	266,666	1,371,832† 548,734‡	733,267	805,633 §	304,012 §
Tons of coal usefully employed * gross	60.735	60.735	41.714	177,166† 70.867‡	70,960	...	...
Tons of coal wasted „	1,083,265	320,216	224,952	1,194,666† 477,867‡	662,307	...	...
Ratio of net coal or oil utilised to useful purpose to gross fuel mined	1 to 27	1 to 9	1 to 6	1 to 32† 1 to 13‡	1 to 12	1 to 19	1 to 7
± Saving over coke fuel pit furnaces in terms of coal used to melt and superheat 2,000,000 tons of ordinary brass	...	+ 762,040	+ 876,334	−228,832† + 594,266‡	+ 409,733	...	...

* Allowing for losses in production of coke, &c. † Inclusive coke produced. ‡ Exclusive coke produced.
§ Heat equivalent value of oil in terms of coal.

NOTE.—Figures given above for "gross" tons of coal used in the case of "town gas" include the by-products gas-coke, coal-tar, &c., the commercial value of which would be deducted before arriving at a final efficiency figure for this system of heat development and application.

Brass can be melted with a consumption of about 20 cub. ft. of 135 B.T.U. gas per lb. of brass in tilting furnaces, and with about the same consumption in multiple crucible pit furnaces. For this low-power producer-gas 1 lb. of coal will yield, say, 60 cub. ft. of gas, so that the tonnage of coal required for pit and tilting furnaces would be about 666,607 tons to melt and superheat the brass, plus 10 per cent. at least for losses in the producer, which brings coal consumption to, say, 733,267 tons, costing as many £ sterling. Thus there would be a virtual saving of, roughly, 40 per cent. in quantity of coal

tion. An air cavity is suggested between the inner and outer firebrick lining for insulating purposes, or the cavity can be packed with zirconia earth. The outside of the furnace to be fitted with expanded metal for lagging. The flue outlet to be central, and the flame issuing therefrom to be at any time visible to the operator. The secondary flue opening to the main flue to be controlled by means of a damper, and a preheating hearth to be arranged in this flue passage. The furnace to have an outside metal cover, so that all products of combustion and zinc smother will be drawn into the

main flue. The bottom to be in the form of a hinged pan for collection of spilled metal, and the space above filled with quartz nodules into which slag can soak below the level of useful fuel (in coke-fired furnaces) and away from the burner inlet of oil- or gas-fired furnaces.

When it is essential to use small crucibles, greater economy can be obtained in multiple crucible furnaces. Some useful types of gas-fired furnaces, such as the Hermansen furnace and the Parsy furnace, have recently been described. The author himself has designed, some years ago, an oil-fired multiple crucible furnace which gets over the usual difficulty in respect of the absence of control of individual crucibles in furnaces having a large common melting chamber. In the author's design (Figs. 2 and 3) the common melting chamber is at the base and the upper portion is divided into separate chambers, each with its own outlet into the flue. It is found that removing a cover does not in any way affect the melting conditions in the other chambers. The design makes it possible to use two instead of six burners for a 6-crucible unit. The working efficiency of this multiple furnace is about 10 per cent., as compared with 5 per cent. in the case of single-crucible furnaces. The poor quality of refractories used as linings and their worn and broken condition are in a great measure responsible for the ever-varying fuel consumption. In order to overcome this trouble to some extent in tilting furnaces the author has suggested a special form of grate pan, which he described and the action of which he explained.

Radiation losses can be reduced to a certain extent by providing composite linings. It is well known that the most refractory materials, such as carborundum, are at the same time good conductors of heat. In the "Foundry Trade Journal" for July 12, 1912, certain facts bearing upon this were noted; for instance, a firebrick of moderately good quality, although relatively inferior as a refractory material, was shown to have radiated much less heat than the higher-grade refractories—silica, alundum, silicon, carbide, magnesia—whereas the ordinary red building brick showed undoubtedly the best insulating properties. An inch of lagging on the outside of the furnace also reduced heat radiation losses by more than 50 per cent. The greatest loss of heat in a melting furnace occurs in the waste gases, and it has been proposed that CO_2 recorders should be used as a guide to the state of combustion, but with, say, 50 pit fires connected to one main flue, it would be necessary to fit a CO_2 recorder in each individual branch flue. An analysis of gas in the main collective flue would not indicate which furnace was working inefficiently.

The Tax on Brass Swarf.

At a meeting of the Birmingham Brassmasters' Association held at the Grand Hotel, Birmingham, last month, to consider the question of export trade after the war, addresses were delivered by Mr. L. A. Paish, formerly of the Board of Trade, but now of the new Department of Commercial Intelligence, and Mr. C. Hamilton Wickes, British Trade Commissioner in Canada and Newfoundland. There was a large and representative attendance. Mr. J. W. Madeley, Chairman of the Association Committee, presided.

The CHAIRMAN reported the result of an interview with the authorities in London respecting the swarf question. He thought they recognised that the drastic Order which the Ministry had introduced respecting the disposal of brass swarf must be modified. It was understood that a conference would be held to clear up some details which required to be dealt with before the matter was finally settled, as soon as ever the Ministry could make arrangements with its financial department. They would agree that the future welfare of this country was very largely dependent upon what they were going to do in their after-the-war business propositions. They must not lull themselves into a state of security by imagining for one moment that the war, which had cost Germany so much, had in the least dulled her intense desire to dominate the trade of the world. There was no worse organised trade in Birmingham or in the country than the brass trade, and there was an enormous amount of competition in it. They had large firms in Birmingham which had no less than something like 22,000 sets of patterns, probably each set averaging four or five patterns, and they were manufacturing from these to meet the demands of the trade. He did not think that any level-minded manufacturer would imagine for one moment that it was possible to produce competitive articles at a competitive price on such a programme as that. They had to organise, they had to specialise, they had to co-operate. Unless those three paths in industrial development were followed to their logical issue, he was afraid that in the after-the-war race for trade this country would be found to be in a most unfortunate position. Take the question of the costing of the goods. There were various methods used by various manufacturers. They could not all be correct. There was a necessity, and a very urgent necessity, for manufacturers to meet together and to co-operate to form some organisation whereby they might get the best technical advice that it was possible to obtain and to formulate systems whereby actual costs might be ascertained and whereby manufacturers might know exactly where they stood. At the present time there were innumerable goods sold by manufacturers in Birmingham of which the makers did not know the actual cost. The only statistics upon which were based the prices which appeared in their catalogues were the prices of their competitors. The huge debt which had been piled up during the war was one which could not be met by their private contributions to the revenue; it must be met by national contributions, and unless these national contributions were on such a scale that they held within their limits the contributions of the whole of the workpeople employed on such goods it was quite a forlorn hope that they would be able to evolve national prosperity out of the present crisis.

MR. L. A. PAISH said that when he left town he was in a department of the Board of Trade. Since then he had seen a notification in the Press of the formation of that new Department, the Department of Commercial Intelligence, and presumably he now belonged to that. That Department was one which had been formed to amalagamate, combine, and federate the whole of the Commercial Intelligence Departments of the Government. The idea was that they should place under one control the duty of giving commercial information to the commercial community of this country. The announcement that the President of the new Department was to be Sir A. Steel-Maitland would be very highly appreciated by Birmingham manufacturers.

ARSENIC IN COKE.—According to Simmersbach, Schinz in his book on blast furnaces pointed out as long ago as 1868 that Belgian and Saarbrück coke contain arsenic. Tests lately carried out in the cokery laboratory of the Technical High School of Breslau gave the following percentages for the arsenic content in various samples of coke: (1) Westphalia coke, 0.011; (2) Rhineland coke, 0.002; (3) coke from Saar district, 0.0052; (4) American beehive coke, 0.0037. The arsenic was estimated by the Archbutt-Jackson method in every case. Blast-furnace coke in the Midlands and gas coke from Yorkshire have also been found to contain traces of arsenic.

Steel Slags and Their Uses.*

Owing to some interesting uses to which the necessities of war in the steel industry of Europe have caused certain steel slags to be put, the writer was prompted, some time ago, to make an investigation of American slags.

Six important slags regularly turned out by American steel companies are dealt with in this analysis. They all differ decidedly in properties, and are from (*a*) basic open-hearth furnaces; (*b*) acid open-hearth furnaces; (*c*) acid Bessemer converters; (*d*) converters making manganese steel; (*e*) blast furnaces making manganese alloys; and (*f*) blast furnaces making pig-iron. Considering these various slags from their value as manganese carriers, the following recapitulation is interesting :—

Slag.	MnO, Per cent
Basic open-hearth	2.5 to 10.0
Acid open-hearth	3.0 to 21.0
Bessemer converter	5.0 to 22.0
Manganese steel	45.0 to 50.0
Ferro-manganese furnace	5.0 to 12.0
Spiegeleisen furnace	2.5 to 5.0

Since the war started and manganese ores became scarce, a good market was formed for the high-manganese slag from manganese steel converters. This 45 to 50 per cent. manganese-oxide slag has been sold to one or two companies making ferro-manganese. It has been used in their regular burden, and a large part of the manganese has been recovered, as well as some of the iron. Open-hearth and Bessemer slags, particularly basic, are metallurgically available for use in regular blast-furnace burdens, and economically so in many cases. But it is surprising to learn how few pig-iron makers are really availing themselves of this advantage.

Basic slags are now being run through blast furnaces to recover the lime and some of the iron, but particularly the manganese. One of the largest pig-iron and steel producers in the United States has in the past year or two raised the manganese content of its basic and other pig-iron from 0.90 per cent. to 1.50 per cent. by the use of basic slags alone. Some of the phosphorus is also given up, and when this becomes too high the charge of slag is discontinued temporarily or for one day.

Slags, as a whole, are by-products containing valuable ingredients. The basic, in particular, can easily be used, and it is believed that the successful employment of the acid slags can be advantageously worked out. Bearing directly on these questions is the testimony of one large American steel and pig-iron maker, which is so explicit and illuminating that it is here quoted :—

"From our open-hearth slag we recover the metallic contents, iron 18 per cent. plus phosphorus 1 per cent. plus manganese 10.50 per cent. This is equal to an ore value of approximately 25 per cent. in iron, figuring that we lose 40 per cent manganese in furnace practice. This, of course, will vary according to temperatures. Besides recovering the iron, we figure a limestone valuation of about 50 per cent. That is, from every 100 lbs. of open-hearth slag in use we get a credit in stone of 50 lbs., or we might say that we take off 50 lbs. of stone for every 100 lbs. of open-hearth slag used. *We figure that it costs the open-hearth department about* $8 *per car to waste the open-hearth slag which is saved by using it in the blast furnace.* In another furnace we use Bessemer converter slag and recover the metallic contents, iron 8.50 per cent. plus manganese 14 per cent., or equivalent to iron ore of 16 per cent. With converter slag we have a silica content of about 58 per cent., which enables us to use a lower silica ore, consequently giving us a richer mix, and at the same time not too dry a burden, which reflects in the coke practice."

In Sweden two different procedures are being carried out for reducing, electrically, acid slags to alloys high in manganese. The first is the use to which slag from their Bessemer converters is put. In Swedish practice a pig-iron containing as high as 2 per cent. manganese is used, the manganese being the chief source of heat because Swedish pig-iron is very low in silicon and phosphorus. As a result, a Bessemer acid slag is obtained very high in manganese, sometimes reaching 50 per cent. MnO. Another Swedish slag comes from the blast furnaces making pig-iron. In producing an iron as high as 2 per cent. in manganese the slags have a very high manganese content also. Some are stated to average 20 per cent. in manganese oxide.

Since the war started, and ferro-manganese and other manganese alloys for steel-making purposes grew scarcer in Sweden, attempts were made to recover the manganese. The Swedish Bessemer slag is reduced with charcoal in an electric furnace, by which means a product is obtained containing about 60 per cent. manganese, with the balance made up largely of silicon and iron.

From another source comes the information that the Swedish blast-furnace slags, which carry about 20 per cent. manganese oxide, are treated in an arc electric furnace requiring 1,700 kw. and producing an alloy containing 60 per cent. manganese and 20 per cent. silicon. Because of the high silicon content the usual absorption of carbon is stated to be prevented so that it averages less than the usual 80 per cent. ferro-manganese. Reliable information is to the effect that the Germans are carrying out one or both of the electric reduction methods for slags referred to, and using such alloys as substitutes for ferro-manganese.

A rough theoretical calculation shows a total slag output of, say, 2,373,500 tons in the United States in 1913, which contains approximately 148,376 tons of MnO, or 114,249 tons of manganese. It was much larger in 1916. The basic slag alone shows a manganese content of 86,159 tons of manganese, most of which is recoverable as manganese in the pig-iron. The acid slags, Bessemer and open-hearth, contain 28,090 tons of manganese.

* Edwin F. Cone in "The Iron Age."

THE BRITISH FOUNDRYMEN'S ASSOCIATION: NEWCASTLE BRANCH.—The annual report of this Branch states that during the past session eight meetings have been held, and the attendances have shown a marked improvement on previous years. The membership is increasing satisfactorily, the total being now 116, comprising 31 members, 54 associate members, and 31 associates. In regard to the proposed Surtees' Memorial, the position generally with regard to this project has, owing to the war, not proceeded very far. The following promises of financial support have been made:—W. Mayer, £25; H. A. J. Rang, £2 2s.; W. Henderson, £1 1s. Mr. R. Wallis, Past President, is preparing a Paper on the "Life Work of the late Mr. Surtees," and, probably deliver it during the next session.

Composition of Shell Steel.

Mr. Reginald Trautschold, writing in "Metallurgical and Chemical Engineering," states that the English specifications for high-explosive shell steels are probably the most exacting of any, but those imposed by the United States are sufficiently exacting to prohibit the use of much otherwise available and excellent steel stock. The percentages of chemical elements which may occur in high-explosive shell steel are given in Table I. The allowable percentage of certain elements is so small that exacting mixtures of metal are essential. Compared with such requirements, the chemical properties of the steel used by the Germans

Table I.—*United States Specifications.*

	Maximum Per cent.		Maximum Per cent.
Carbon	.. 0.55	Phosphorus	0.04
Manganese ..	0.40 to 1.00	Copper	0.10
Silicon	.. 0.30	Nickel	0.50
Sulphur	0.04		

are of particular interest. During the first year of the war a number of fragments of the German high-explosive shells were collected at the front and carefully analysed in England, and the analysis of the collected samples as published by Dr. J. E. Stead in 1916 probably depicts the best German practice.*

Comparing the chemical analyses of Dr. Stead's German shells with corresponding allowable percentages in the United States specifications, it will be noted that not one German shell would have passed U.S. requirements. Yet every one of these shells was a highly efficient destructive missile. In the case of carbon content, which according to the U.S. specifications is limited to 0.55 per cent., there were only two of these tested shells which did not exceed this maximum: in one case the excess was over 100 per cent., while the average excess was 28 per cent.

In Table II. are given the allowable chemical variation which would be permitted by the Germans, basing the percentages upon the 21 typical shells that were analysed. The establishment of definite specifications on 21 analyses could not, of course, be taken as conclusive evidence that the variations shown may not be exceeded, but, as there is no reason to assume that the fragments examined were other than typical, such

Table II.—*Probable German Specifications.*

	Minimum Per cent.	Average Per cent.	Maximum Per cent.
Carbon	0.40	0.75	1.12
Manganese	0.40	0.93	1.40
Silicon	0.00	0.28	0.60
Sulphur	0.00	0.05	0.085
Phosphorus	0.00	0.06	0.105
Copper	0.00	—	1.00

specifications may safely be accepted. These allowances may be more exacting than those permitted by the German Government, but they are certainly not more liberal. Should some such specifications as these be adopted by the United States, it would make available a considerable tonnage of steel which to-day cannot be used in the production of high-explosive shells. With a larger steel supply available, the production of shells could, of course, be greatly accelerated.

The wide variations in the composition of German high-explosive shell steel indicate that not only are no exact chemical requirements imposed, but also indicate the strong probability that the requirements for acceptable shell steel are not based on chemical but upon physical properties. This theory is endorsed to some extent by the French, who lay particular stress on exhaustive and reliable physical tests while imposing little limitation as to chemical composition. The chemical composition of steel can only be taken as indicating what its physical properties *may* be. It cannot be accepted as a definite indication, and for this reason all Governments require confirmatory physical tests. It would seem the part of wisdom, therefore, to rely more on physical tests and impose less strenuous chemical requirements.

* See "Foundry Trade Journal," March, 1916.

Correspondence.

The Effect of Silicon in Cast Iron.

To the Editor of the Foundry Trade Journal.

Sir,—I have read with interest the letter of your correspondent "Ajax," and quite agree with the metallurgical part of it. The only comments I might make deal with the first paragraph of this letter. "Ajax" suggests that I have adopted the "method of making non-committal statements, which leave one in doubt as to their precise meaning." It is a little regrettable that he does not quote a single one of these statements. His criticism, therefore, not only loses point, but becomes itself one of those non-committal statements he is girding at.

Mr. Adamson's letter on the same page does not require much attention. It is a little unfortunate that he should consider it *unnecessary* to reply to my letter on page 436. Your editorial comments only dealt specifically with one point of my letter, regarding my definition of the word "control." There were a good many other points which Mr. Adamson is unwilling to deal with. In his last letter (page 492) Mr. Adamson remarks that a sentence in my previous letter "indicates a lack of understanding of blast furnace practice," and that otherwise I should have understood your editorial rendering—which he believes is also his—of the meaning of the term "heredity" in pig-iron. This is a little curious, because on page 436 I showed quite clearly what I understood by the term "heredity." Mr. Adamson will not say that he agrees or disagrees with this. I am, therefore, anxious to learn whether my rendering of the term "heredity" in his opinion differs from his own, and, if so, in what way?—Yours, etc.,

R. T. Rolfe.

Bedford, September 15, 1917.

BRITISH FOUNDRYMEN'S ASSOCIATION: LONDON BRANCH. — The annual meeting of this Branch was held on Saturday, September 15, 1917, when Mr. A. R. Bartlett, retiring Branch-President, occupied the chair at the opening. The Secretary's report showed that the membership had increased to 117, comprising 47 members, 65 associate members, and 5 associates. In 1916 the membership was 109. Mr. T. W. Aitken (Luton) was elected President for the ensuing session. Lieut. D. Gordon, R.N.V.R., senior Vice-President, and Mr. J. Stone (Blackheath) junior Vice-President. Mr J. Gaunt was unanimously elected Branch Secretary, and Messrs. A. R. Bartlett and D. Gordon were chosen as representatives on the General Council for the next two years. The ballot for election of Branch Councilmen to fill the customary vacancies by retiral resulted in the election of Messrs. H. O. Beere, W. Ellis, B. F. Sperring, R. Woods, W. H. Aston, and Lieut. A. Hayes, R.N.V.R. The meeting concluded with an evening of social intercourse and music.

Investigation Upon a Cast of Acid Open-Hearth Steel.*

By T. D. Morgans (Blaenavon, Mon.)
and
F. Rogers, D.Eng., B.A., M.Sc. (Sheffield).

The work described in the present Paper was undertaken at the request of Colonel Stansfeld, Deputy Director-General of Munitions Inspection, with a view to determining the general quality and uniformity of the acid open-hearth steel made at the Blaenavon Company's works for the manufacture of H.E. shell.

The plan of the investigation consisted in making the following analyses and tests from pit samples and from the top, middle, and bottom billets from one of the 40-ton acid open-hearth furnaces:—

(1) Analyses of pit samples taken immediately before casting each ingot; (2) analyses of the top, middle, and bottom billets from each ingot; (3) tensile test from the same; (4) Brinell test from the same; (5) microscopic examination of the same.

The results of the tests were plotted in a diagram and illustrated in a representative selection of photo-micrographs, which accompany the Paper.

Experimental Cast.—The following are general particulars of the cast (No. 174) investigated:—

	Tons.	Cwts.	Qrs.
Pig iron	19	1	0
Heavy scrap	21	8	0
Shell steel turnings	3	0	0
Ferro-manganese	0	11	3
Ferro-silicon (50 per cent. silicon)	0	2	1
Iron ore	2	0	0
Limestone, about	0	14	0
Total	46	17	0

The ferro-manganese and ferro-silicon were put into the bath; none into the ladle. Size of mould 18½ in. by 16½ in. at top and 16½ in. by 14 in. at bottom. Total length of ingot, 5 ft. 6 in. (including head). Approximate weight of ingot, 40 cwt.

Analyses of Pit Samples.—The range of variation of carbon was from 0.491 to 0.551 per cent.; of phosphorus, 0.039 to 0.044 per cent.; of sulphur, 0.054 to 0.063 per cent:; of manganese, 0.765 to 0.875 per cent; of silicon, 0.168 to 0.182 per cent. The irregularities in carbon, phosphorus, and silicon were practically negligible. The variations of sulphur and manganese were more noticeable, but there was a fairly general fall of sulphur and manganese during the teeming of the ingots—a period of about twenty minutes. The fall of manganese was evidently due mainly to the continuance of its deoxidising action.

Analyses of the Three Billets of Each Ingot.—The primary feature of the analyses was their regularity. The variation of the sulphur no longer followed a definite fall, while manganese appeared definitely to fall in every case. In the bottom bars silicon also appeared to have fallen. The mean results are shown in the following table:—

	Carbon.	Phosphorus.	Sulphur.	Manganese.	Silicon.
Mean, top bars ..	0.542	0.045	0.058	0.840	0.177
,, middle bars	0.524	0.043	0.055	0.831	0.178
,, bottom bars	0.519	0.039	0.051	0.829	0.167
Pit sample means	0.514	0.042	0.057	0.810	0.175

It should be noted, as a rough generalisation upon the whole of the analyses, that the range of variation in each element is of the order of one-tenth of the amount of the element present (*i.e.*, 5 per cent. each way from the mean value), with the exception of silicon in the top and middle bars, which is less than this proportion, and carbon in all the bars, which varies only about 3 per cent. up and down from the mean.

Tensile and Hardness Tests.—The tensile and hardness tests were very uniform, and call for no comment. The averages of the whole cast were as under:—

Average yield stress	23.21	tons per sq. in	
,, maximum	47.15	,,	,,
,, elongation	21.71	per cent.	
,, Brinell hardness number (3,000 kg.)	209.0		

Tests upon Forged Shell.—These were well in accordance with the usual specifications for steel of this class. The elastic limit was over 19 tons per sq. in.; the maximum stress 47.6 to 48.1 tons per sq. in., and the elongation on 2 in. 21.6 per cent.

Section of Ingot.—A photograph of a section of an ingot from another cast, the particulars of whose manufacture were practically identical with those for the experimental cast, showed that the pipe was very satisfactorily located in the head, and its form indicated no tendency to secondary pipe.

Microstructure.—Photomicrographs were taken under comparative conditions from seventeen of the billets at random, the magnification being 50 diameters. Three photomicrographs at a higher magnification (500 diameters) showed in greater detail the nature of the structure, which consisted of a ferrite network, partially discontinuous in places, whose meshes were filled with generally lamellar pearlite. Towards the edges of the billet the network size was smaller, and towards the centre larger than at the field adopted as standard for the photomicrographs. In many places there were isolated large meshes (or local discontinuities of the net work according to the point of view). Throughout the general microscopic examination of all the pieces no features were encountered which could be classed as defects in a steel of this class. The variations of structure which were encountered were such as ordinarily occur in good steel of this class. Such variations, including local differences of network size, were not in any instance of a nature which would prove detrimental to the steel for the purposes for which it was intended.

* Abstract of Paper read before the Iron and Steel Institute.

WEDGE AND RINGLESS STRIP-CASTERS' INGOT MOULDS.—We have received from Mr. Ernest Harris, 233, Bankes Road, Small Heath, Birmingham, particulars of a new strip-casters' ingot mould, designed to save time and labour in the casting of strip metals. The design is intended to obviate the loss of time and labour, with the ingot moulds now in use, on account of the rings or wedges being loose or detachable from mould, and which are constantly being mislaid or lost when released after casting. With the new moulds the "back" and "cover" are clamped together by side clips with screwed shanks, operating in the "back" part, and fixed to same, the clips only being removed for repair or renewal. Each mould, therefore, being complete in itself, enables the workman to proceed without wasting time looking for the rings or wedges. The moulds, it is claimed, after being dressed can be closed and clamped in 20 seconds. The clips are forced round with a hammer, a light blow being all that is necessary to make a secure clamping together of back and cover, the moulds being then ready for pouring. There is also a projecting ledge cast on the back of the mould, which rests in a secure position against the stand, and keeps the mould at a uniform height and angle for pouring.

Chemical Standards for the Iron and Steel Industry.

The need for standard analysed samples has been constantly felt by chemists who wish to check their own working, and by others who want a basis for readily comparing various analysts' results. The trouble and expense which manufacturers and others experience through analytical differences are only too well known by those concerned,* but it is obvious that by suitable use of a standard much of this can be avoided.

One manifest advantage of running a standard through side by side with a sample of unknown composition as a check upon variable factors, is that if it agrees with the standard figures it demonstrates the correctness of the methods used and the working of them, and in any event *the results can be expressed in terms of the standard.*

The imperative need of standards has for a long time led many chemists to prepare standards for their own use; but these, no matter how intrinsically good they may be, can never have more than a very restricted value; the ideal earnestly desired being standards which have been tested by a number of chemists and widely adopted. So far as we know, these have not until the last year been obtainable in this country, the reason being no doubt the difficulties involved, which were too great from the individual point of view, especially as they presented no prospect of profit commercially. Hence the general feeling has always been that some public body should prepare them, but, in spite of the ample time and opportunities they have had, over the last twenty years, nothing effective and permanent has yet been achieved. As any help from these bodies seemed hopeless, and meanwhile the scientific and commercial need for an immediate supply of standards grew stronger than ever—whilst the United States Bureau of Standards, on being approached, explained that the requirements for domestic consumption precluded the supply of any appreciable quantity for abroad—it became evident that if matters were not to remain at a standstill, the production of standards in this country would have to depend, in the early stages at least, on private enterprise; and unless the initiators were prepared to make appreciable sacrifices, both as to trouble and financial risk—the expenses of preparing a single sample running from £20 to £30—it would not be done.

Accordingly—as for nearly two years a movement, modelled largely on the lines originated by the United States Bureau of Standards (to whom acknowledgment is here made) has been in progress, and has now gained considerable ground—it is believed the brief account here given will be of interest. The organisers of it are Mr. C. H. Ridsdale (who had for many years been an ardent advocate of all that would conduce to the unification of analytical results, and had had long experience in the preparation of private standards) and Mr. N. D. Ridsdale. They decided to ask a large number of chemists with whom they were constantly in touch to co-operate with them, and so not only share the burden, but at the same time invest the standards with an authoritative value which could not be obtained in any other way.

From the first, endeavour was made to set out the scheme on such a broad basis as should render it worthy of the widest adoption, and should permit of such growth as to justify the name adopted—"British Chemical Standards." Recognising that a condition which would specially give value to any standard would be that the chemists who determined its composition should not be all of one type (as, say, public analysts), or district, (as, say, Cleveland), but selected from opposite sections of the industry and widely different districts, to avoid any idea of local interest being associated with it, they took the opinion of chemists of standing all over the country, not only as to the desirability of the effort being made, but also as to which standards should be pushed on with first, and received a hearty response. In spite of the exceptional difficulties which the war imposes, a number of chemists and firms have already voluntarily co-operated, some firms having kindly offered specially prepared material for the standards.

The cost, having thus been mainly for the preparation and distribution, has enabled standards to be obtained in greater variety and quantity, and to be issued at a very low rate, much beneath what has been usual for privately prepared standards, whilst the liberty of action and elasticity of the scheme permitted quicker action than if carried out by some public body.

After successfully overcoming many preliminary difficulties the scheme was matured, and in the summer of 1916 some preliminary standards in the testing of which five chemists had co-operated were issued, followed in the autumn by the first of the series of standards, each tested by not less than *eight* different chemists. Already there have been five of these later standards selected and issued in accordance with their importance:—

Mark. Type.	Carbon	Silicon	Sulph'r	Phosphorus	Manganese.	Arsenic
	%	%	%	%	%	%
"A 1" basic steel	0.05	0.006	0.037	0.026	0.310	0.035
"B 3" " "	0.412	0.104	0.048	0.060	0.791	0.066
"B 4" " "	0.404	0.027	0.046	0.101	0.735	0.140
"Q" acid open-hearth	0.676	—	—	—	0.73	—
"S" acid open-hearth	0·905	—	—	—	0.88	—

Three more — special steels and cast-iron — are already in preparation and others arranged for. This may seem slow progress, but the preparation in quantity of absolutely homogeneous samples is very tedious and requires the utmost precaution all through, whilst the analysis of each one raises as it proceeds numerous points as to methods, and requires frequent repeat tests. This is one of the immediate and highly valuable results of the use of standards; but it all takes time, and a single standard needs several months to prepare.

The standards are generally issued in 100-gramme portions (in the case of standards for carbon only, 50 grammes), each with a certificate bearing the names of the co-operating chemists, and showing the method used, the results being classified according to these. In order to co-ordinate the results with steels issued by the United States Bureau of Standards, tests of each have been made side by side at headquarters. How eagerly standards of such character were awaited may be judged from the fact that already some 30,000 grammes have been issued in the British Isles and abroad, whilst 80 users have adopted them.

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* In a Paper and discussion on the subject, "The Introduction of Standard Methods of Analysis," *Journ. I. and S. Inst.*, vol. I., 1896, pp. 80-138, the matter is very well presented; and the position from its commercial point of view is summarised in "Mechanicalising Analysis," *Ibid.* vol. I., 1911, pp. 332-3: also in "Standardising Rapid Analytical Methods," *Journ. W. of Scot. I. and S. Inst.*, No. 2, Nov., 1911, p. 38.

Producer Gas from Coke for the Open-Hearth Furnace.

Dr. H. Markgraf, in a recent issue of "Stahl und Eisen," suggests further research and investigation of the question why producer gas from coke should behave so differently in the open-hearth furnace from producer gas of "similar composition" from coal. Failures and breakdowns of gas producers working with coke are often due to the fuel not being of the proper size. If the lumps are too large, the oxygen in the air passes through the loose mass too quickly and has no time to undergo the necessary chemical changes to produce a serviceable gas. If, on the other hand, the coke is too fine, the pressure of the gas is insufficient to break through the dense mass, or at any rate to pass through the bed evenly distributed. To improve the working, coke is sometimes mixed with coal in the producer, in which case sometimes the mistake is made of using fuels which, when mixed together, cake too easily and the producer quickly becomes clogged. Such fuels should be gasified separately. Assuming, however, that coke gas "similar in composition" to producer gas from coal is available, it will still be found that the coke gas behaves differently, and that as a consequence the open-hearth furnace will not work satisfactorily. It is often asserted that the quantity of gas derived from coke is smaller than that from coal, and that consequently it takes longer to finish a charge in the furnace; but, in the author's opinion, this is a mistaken notion. As a matter of fact, more gas can be got out of coke than out of the same weight of coal. Still, the fact remains that even with plenty of coke gas of good quality the charge takes longer to finish than with coal gas from the producer. To discover the reason for this, careful observations and systematic trials were made with an open-hearth furnace of 35 to 40 tons capacity. It was found that with a mixture of one-third of coke to two-thirds of coal, by weight, the furnace was working quite satisfactorily, but troubles arose when the two fuels were mixed weight for weight, while when coke exclusively was used the charge could not be finished at all. The working of the furnace improved when by suitable air regulation a long flame was produced. The gas had very little illuminating power, but still the flame was visible. At the same time the temperature was sufficiently high to start fusing the arch in places, and also the ports. The heat in the furnace chamber was intense, but yet the bath of molten metal did not work satisfactorily. Several trials were made with the same results.

A careful inspection revealed the fact that when working with coke gas the flame remained in close touch with the bath for only a third of the length of the furnace, past which point it left the path of the draft, spread itself out, and attacked the roof. When working with producer gas from coal, on the contrary, the flame remained in close contact with the bath along the whole length of the furnace without any tendency to disperse and spread to the roof.

The author attempts to explain this difference in the behaviour of two gases of similar composition, and suspects it to be due to the absence in the one case, and the presence in the other, of hydrocarbon vapours of a certain composition. The vaporised hydrocarbons in the gas, which in the cooler places, in flues and ducts are deposited as tar or a tarry crust, are changed—the author thinks—in the intensely hot furnace chamber into simpler compounds, when some of the carbon is liberated and becomes incandescent. This will account for the difference in the luminosity of the two flames, but why the flame should disperse itself in one case and not in the other still remains a mystery. The design of the furnace head, which the author was unable to change, may have something to do with it; hence his call for further and more systematic observations, as coke gas would be more extensively used if a successful method of working with it could be discovered. At present more coke gas has to be used and a stronger draft than with producer gas from coal to make the flame do its work.

The article elicited remarks from several correspondents, some of whom called for, and obtained through the editor, analyses of the two gases in question, which were as follows:—

—	Coke gas.	Coal gas.
	Per cent.	Per cent.
Carbon dioxide	4 to 5	3 to 4
Carbon monoxide	26 to 27	27 to 29
H_2	8 to 9	10 to 12
Methane	0.7	1.5
N_2	61.3 to 58.3	58.5 to 53.5
Calculated calories	1,055 to 1,111	1,206 to 1,315

The comparative calorific values, which have been calculated by one of the correspondents and have been added in the above table, show that, to begin with, the coal gas has a higher calorific value than the coke gas, the difference between the mean values amounting to 17 per cent. Moreover, assuming that both gases contained the same amount of steam, that the air for the furnace was heated to 1,300 deg. and the gas to 1,200 deg. and using the theoretical amount of air, the temperature of the flame produced by coal gas would be 2,475 deg. and that by coke gas only 2,385 deg. A difference of 90 deg. would be of no consequence when melting down the charge or at the start, but would make itself felt towards the finish, the more so the nearer the melting point of the charge approached the flame temperature. The difference in calories alone would therefore suffice to explain why with coke gas the charge took such a long time to finish or could not be finished at all. But a more important factor to consider would be the dust and tar contents of the gas, as these, especially the latter, would have great influence on the way in which the flame was formed. The rates at which carbon monoxide, hydrogen and the heavy hydrocarbons burn are in the proportion of 2 : 4.5 : 6.5. With an adequate air supply the hydrocarbons are immediately decomposed into carbon dioxide and steam. A gas rich in hydrocarbons and hydrogen respectively will therefore give a short but intensely hot flame within a limited area. Hence the difference in the flames of coal gas and of a gas poor in hydrocarbons, hydrogen

and tar vapours. The former will burn quicker and be consumed nearer to the entry ports, while the latter will burn more slowly, and the process of consumption will be spread over the whole furnace length. Hence, in order to maintain the efficiency of the furnace more coke gas will have to be used than coal gas. Theoretically, 1.28 cubic units of coke gas will be required to do the work of one cubic unit of coal gas (which is borne out by the results arrived at in British producer gas practice for power purposes), but in actual furnace practice it will be found that the extra quantity of coke gas required will be nearer 40 per cent.

The same correspondent adds some interesting particulars, obtained with a 50-ton furnace, from a private source. The experiments were carried out in order to settle the question whether it would pay to recover the by-products before using producer coal gas in the open-hearth furnace. The gas was thoroughly cooled and almost freed from soot, tar and moisture. With this purified gas the charge in the furnace took an uncommonly long time, which was shortened when the gas was mixed with coke gas, but it still exceeded the time taken with unpurified producer gas from coal, and the idea of by-product recovery was therefore abandoned. Pyrometric measurements of the temperature of the flame (and not of the brick lining of the furnace) through openings at five equidistant intermediate points gave the following results:—(1) In the case of unpurified gas the temperature attained its maximum immediately after ignition, and then steadily dropped until the exit ports were reached. The rate of drop was greatest along the first third of the furnace length, after which it became somewhat less. (2) In the case of the purified gas, on the other hand, the temperature reached after ignition was less than in case (1), and remained almost steady during the first half of the furnace length (points 1 to 3), and even rose slightly; then there was a rapid fall between observation points 3 and 4 and only a slight fall between 4 and 5. When plotted, the curves for the unpurified gas represented parabola-like lines, with their concave side turned upwards, while the purified gas gave S curves. The flames in the two cases were therefore totally different, and the unpurified gas gave what must probably be considered the more suitable flame. The unpurified gas gave an intensely hot flame, and was seemingly consumed within the first third of the furnace length. With the purified gas the flame was developed along the first half of the furnace length, the development of heat was more uniform, and the heat less intense. The difference in the flame could be noticed through the blue glasses also. The charge with the purified gas took 1 to 1½ hours longer. No alteration whatever was made in the furnace, the drafts of the air and gas were good at both heads, the temperature of the gases on leaving the furnace was practically the same in both cases, the preheating, at least that of the air, was approximately the same, and the calorific value of the purified gas was very high (1,710 to 2,140 calories), so that the abstraction of the tar and soot could not be made responsible for the delay in finishing the charge, which must therefore be ascribed entirely to the difference in the flame.

Another correspondent gave account of his experience 15 years ago with coke-gas fired furnaces as a permanent practice. There was no need to make any alteration in the furnace. The same open-hearth furnace can be made to work satisfactorily with either kind of gas, but while the regulation of gas and air supplies with coal gas may safely be left to the man in charge if he is a reliable and competent man, the regulation in the case of coke gas becomes a difficult problem. Even at comparatively low temperatures the flame has very low illuminating power, and with rising temperatures it gradually becomes less visible, and it is difficult to see the end of the flame. To make the flame clearer the supply of gas has to be increased and the air supply has to be reduced, with the result that the flame will no longer be guided along the metal bath but will dissipate itself; the charge will take longer, as the heat which should be imparted to it will be diverted to, and attack, the roof. A large quantity of unburnt gas must in such a case escape up the chimney and betray its presence by a long blue flame. The writer's experience was obtained with a 5-ton furnace run for months with coke gas, and later on a standard 15-ton furnace, but for want of proper-sized coke the latter furnace was only occasionally run on coke gas. The reason why coke gas has not been used more extensively in open-hearth furnaces in the past is the great difficulty in controlling the gas and air supplies at high temperatures. The writer recommends coke in cubes of from 0.4 to 1.2 in. for use in the producer. When mixing the coke with coal the two fuels should be gasified separately, as they require different treatment. Although coke gas may offer some difficulty in firing open-hearth, crucible, and other melting furnaces, it is an excellent fuel for low-temperature furnaces, where the gas and air supply valves can be set for once and all, and it is only necessary to watch the gas pressure occasionally.

Yet another correspondent points out that in the coal gas the proportion of combustible constituents to the non-combustible constituents is as 1:1.47 while with coke gas the proportion is 1:1.8.

Dr. Markgraf, in his reply to the correspondents, states that the control of the air and gas supply was not left to the man in charge, and that there was no flame to be observed indicating the escape of unburnt gases from the chimney. He repeats his request that the question should be further studied, and disagrees with the opinion that the design of the furnace, especially of the bridge, does not affect the working with coke gas.

ANALYSIS OF ALUMINIUM ALLOYS.—Mr. J. H. Stansbie, of the Birmingham Technical School, in a Paper on this subject read before the Society of Chemical Industry, stated that the rapid increase in the use of aluminium and its alloys for a variety of purposes made their analysis of considerable importance. For works purpose, the methods of the investigator took up too much time, and shorter though less accurate ones must be used. An analysis which gave the content of a constituent to within 0.1 per cent., or even less in some cases, was sufficiently accurate for the manufacturer, as he could not hope to get within closer limits in making an alloy from a given formula. If the alloy was supplied in bulk, samples obtained by means of a moderately fine metal saw gave good results. Turnings, drillings, or borings were not so convenient. The author gave in detail various methods of analysis, including one devised by the Rev. F. G. Belton, who is doing war work under the direction of Professor Turner, for the determination of nickel in aluminium alloys, which is giving very fair results.

Injurious Dusts in Steel Works.

A recent Technical Paper (No. 153), issued by the U.S. Bureau of Mines, contains an interesting report under the above title, by Mr. J. A. Watkins (Passed Assistant Surgeon of the U.S. Public Health Service), from which we take the following :—

Pathogenicity of Industrial Dusts.—Dust may act injuriously in three different ways, depending on the character of the particles: (1) by irritant action, (2) by toxic action, and (3) by mechanical action. It often happens that a dust acts in two or more of these ways simultaneously. An example of dust which acts in an irritant manner is that from flint chert, or other siliceous rocks. The injurious action of such a dust is due to the particles being hard, sharp, and angular. Of dusts that act in a toxic manner, lead dust is an illustration; while of dusts that act in a purely mechanical manner flour dusts may be cited as an example. Their injurious action lies only in the mechanical interference they may offer to certain physiological processes, as, for example, to that of respiration. Dusts may also be injurious to the eye and its appendages. As regards the ear, owing to its shape dusts are prone to lodge therein, and may interfere with its proper function.

Much of the dust that is inhaled never reaches the lungs, but is caught in the nose, throat, and mouth. Some of it is swallowed and may be poisonous, as lead dust. Other less poisonous dusts may none the less produce inflammation of the throat, and as the skin is the most exposed part of the body, it frequently bears the brunt of the ill effects of industrial dusts.

Occurrence of Dusts in Steel Works.—In handling iron ore, coke and limestone in the storage bins of blast furnaces, more or less dust is produced. About the blast furnaces themselves the suspended matter in the air is mainly graphite, but the lining of the furnace is also responsible for much dust. In plants where the flue dust is caught, and is loaded in cars and taken away, the men working near the dust catchers are exposed to its influences. Cleaning and repairing the stoves is particularly dusty work. Blast-furnace gas is now washed to free it of much of its suspended matter, and while the washers and blowers are in working order and at work there is little dust in the air.

The men engaged in handling dolomite and other refractory materials for lining furnaces, mixers, converters, and reheating furnaces are exposed to enormous quantities of dust, so are the men engaged round an open-hearth furnace, especially soot. During bottom making the dolomite thrown into the furnaces gives rise to a dust cloud. In rolling mills most of the dust consists of roll scale and soot, while in soaking pits with gas-fired reheating furnaces combustion is often incomplete and soot and like carbon products pollute the atmosphere. In addition, during the process of bottom making coke is thrown into the furnaces, and as a result much coke dust rises into the air. A most prolific source of dust is the soft-coal fires under boilers and in furnaces. Dusty conditions are especially noticeable at gas producers, and at Bessemer converters after a blow. When converters are being repaired the dust from the refractory materials pollutes the atmosphere. Where ganister is ground its dust often produces dense clouds. In foundries the building is usually overcrowded and has no flooring of any kind except loose earth. In addition, much hot metal is poured; moulds are made and destroyed, and castings are cleaned and sand-blasted. In the finishing departments emery wheels are used and castings are ground.

In order to determine the extent to which the various dusts were suspended in the atmosphere at various working places in a steel plant a number of air samples were taken and sent to the laboratory for quantitative reports.

Comment on Dusts Collected.—The tables show that at times iron-ore dust is suspended in the atmosphere around the bins in large quantities. It has no toxic action and the particles examined were not very hard. Coke dust occurs in the same places as iron-ore dust, and is also suspended in enormous quantities there. As the particles are lighter they remain suspended for a much longer period. It is not toxic, and acts in a mechanical manner only, but because of its hard, sharp points it no doubt injures the delicate tissues. The particles of limestone dust examined were hard, with decidedly sharp points and edges. Such particles undoubtedly would be irritating to delicate tissues, especially those of the respiratory tract. The flue dust consisted of a mixture of finely divided coke, limestone, and iron ore from the blast-furnace top. Its physiological effects would be a combination of those of the three kinds. With regard to graphite dust, as this is not toxic it is believed to be of no hygienic significance. In respect of industrial hygiene, dolomite is the most important dust in a steel plant, not only because of its character and action but also on account of the enormous quantities of it suspended in the air of certain working places. The dolomite particles examined were very irregular and hard, with few sharp points, but generally with some sharp edges. The dust from ganister rarely becomes suspended in sufficient quantities to be of much hygienic significance.

Abatement of Dusts in the Steel Industry.—All employees about ore bins are exposed to dust, but those particularly liable to be affected are the men operating the skips or the larry cars. Although judiciously sprinkling the stock with water may lessen the dust, sprinkling cannot be done continually or in a manner entirely satisfactory. Men employed at the bins should be furnished with respirators, and be required to wear them. In addition, provisions should be made for ample natural ventilation. At some bins an exhaust system would do much to remove dust. In blast-furnace working it is improbable that dust is a health hazard of much importance. As regards hot-stoves, ordinarily the men employed at these are not exposed to much dust, but all precautionary measures against it should be taken while the stoves are being cleaned or repaired and when the dust catcher is being emptied. Respirators should be required, and as an additional safeguard the dust should be well sprinkled with water, if possible. Men employed about washers and blowers may occasionally be exposed to large amounts of dust, and to meet this condition they should be

required to wear respirators, and the dust should be laid with wet.

As the dolomite shed is sometimes filled with a cloud of dust effective measures of mitigation are most urgent. Much of the dust originates at the grinding machine. To avoid pollution of the air in which men are working, the machine should be placed elsewhere, or should be entirely enclosed and an air-exhaust system installed for removing the dust of grinding. Dust also rises into the air while the calcining furnaces are being charged. In addition, all employees in this department should wear respirators. As a health hazard, the dust in this department has other injurious effects than those to the respiratory tract. The calcined dolomite contains much free lime which when moist irritates the skin and the mucous membranes. This dust accumulates in the clothing and on the skin. When warm weather or hard work makes men perspire freely, the skin is irritated, becomes painful, and a serious condition may result. It is important to have this department equipped with ample washing and bathing facilities, and to require the men to bathe after each turn of duty. In addition, they should gargle water, douche the nose, and wash the teeth in order to clear away all dust. Another important facility that should be provided for these men is a dust-proof clothes locker.

In the open-hearth department dust is neither an urgent nor a difficult condition to meet. In addition, there is always ample natural ventilation in these buildings.

The abatement of soot and dust from soft-coal fires has received much attention lately, and has been discussed at length in several publications of the Bureau of Mines. In a steel plant, dust from this source can be greatly reduced and practically eliminated. With substitution of gas and coke for soft coal in furnaces, etc., and with more care to insure complete combustion, and other improvements in firing methods, this objectionable feature will eventually disappear.

In the Bessemer department attention should be given to preventing dust at the grinding machines in the converter repairing shop. The comment on measures demanded in the dolomite shed is applicable to this department also.

To abate the dust in the foundry a great deal of effort and every means of prevention and mitigation must be employed. Castings should be cleaned and sand-blasted in a separate room, where only those men needed for the work should be allowed to remain, who should be required to wear respirators. Casting should be done in a separate building where precautions should be taken to insure ample ventilation by natural and artificial means. The main foundry room should be given more floor space, and, except where moulds are made, should have suitable flooring of steel plate or brick. The flooring should be sprinkled with water frequently. In addition, provision should be made for an abundant supply of fresh air. Grinding wheels should be supplied with an effective dust exhaust system, and as an additional safeguard the men should be required to wear respirators.

CAPTAIN W. P. SPROUL, who has been wounded and admitted to hospital, is a son of the late Mr. William Sproul, Ibrox, and is a partner in the firm of Messrs. John Richmond & Company, metal merchants, 56, West Regent Street, Glasgow.

Heat Treatment of Coke.

MESSRS. GEORGES CHARPY and MARCEL GODCHOT have recently submitted to the French Academy of Sciences an interesting communication on the influence of the temperature of coking on the suitability of the coke produced for blast-furnace work, The samples of coal experimented upon were crushed and passed through sieves so as to produce fines of almost uniform grain. This was kept for some days in a moist atmosphere at a temperature of about 18 to 20 deg. C., so as to make it absorb a certain amount of moisture. Having reached this state, it was filled and rammed into a small tube of refractory material and then subjected to a pressure of 5 kgs. per sq. cm. (about 71 lbs. per sq. in.). The two ends were then closed with sheet metal discs and the tube placed in an electrical furnace of a size sufficient not to reduce the heat of the furnace appreciably when the tube was introduced.

The experiments were undertaken to ascertain to what extent the temperature of coking affected the compressive strength of the small coke cylinders, 12 mm. (about ½ in.) in diameter, 20 mm. (0.79 in.) long. For this purpose the temperature of the furnace was raised to a pre-arranged temperature, the tube containing the powdered coal was briskly introduced into the furnace and kept there for an hour. Each test was repeated five times under the same conditions, so that six coke cylinders were obtained of each kind of coal coked at each of the following temperatures:—650 deg., 800 deg., and 1,000 deg. C. The cylinders were then crushed in a testing machine and the ultimate stresses per sq. cm. for each specimen tabulated. In the subjoined table only the mean values are given (with their English equivalents in brackets):—

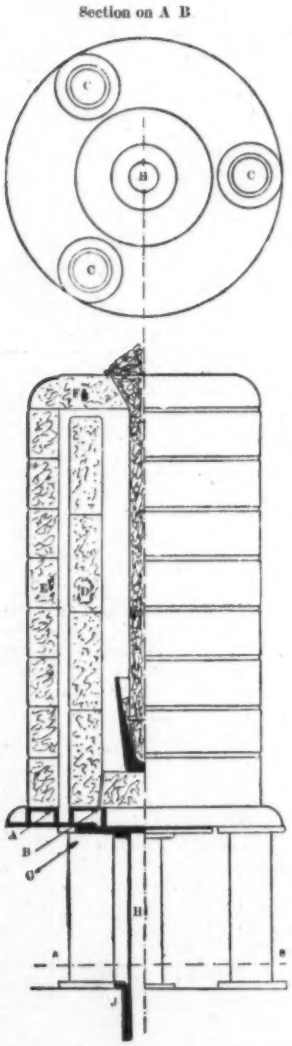
Coking temperature.	St. Eloy.	Ferrières.	Noyant.
Deg. C.	Kgs. p. sq. cm. (Lbs. p. sq. in.)	Kgs. p. sq. cm. (Lbs. p. sq. in.)	Kgs. p. sq. cm. (Lbs. p. sq. in.)
650	19.85 (282)	19.0 (270)	100.0 (1422)
800	32.9 (468)	30.5 (434)	93.6 (1331)
1,000	38.7 (550)	45.0 (640)	36.3 (516)

The authors point out that while the St. Eloy and Ferrières coals gave at the lower temperatures a coke that was practically useless, the coal from Noyant gave at 1,000 deg. C. a coke of a lower crushing strength than the other two coals, while at 650 deg. C. it produced a very firm coke. On the other hand, by varying the treatment, if after heating the coals to 650 deg. C. the temperature was slowly raised to 1,000 deg. C., the St. Eloy coke was not improved at all, while the crushing strength of the Noyant coke was increased to 130 kg. per sq. cm. (1,850 lbs. per sq. in.), which is the proper strength of blast-furnace coke of good quality. These are, no doubt, interesting laboratory experiments, but the authors do not state how their discovery can be turned to good account in coke-oven practice on a commercial basis.

URANIUM STEEL FOR GUN LININGS. — The U.S. Bureau of Mines is to investigate the question of production of ferro-uranium from the uranium oxide obtained as a by-product in the extraction of radium from its ores. Ferro-uranium is used in making uranium steel, used in Germany, it is said, for the linings of big guns.

Improvements in Crucible Furnaces for Melting Scrap, etc.

Hitherto the efficiency attained in gas-heated melting furnaces for dealing with material of low density, such, for example, as brass swarf, has been very low. The furnace which we illustrate has been designed with a view to improving the efficiency. It consists essentially in arranging the material to be melted in a tube forming the feed column above the crucible, such tube being surrounded by a cylinder venting at the top into another cylinder vented at the bottom. The invention also provides for discharging the melted material by lowering the crucible out of the inner cylinder.



IMPROVED CRUCIBLE FURNACE FOR MELTING SCRAP.

Referring to our sectional illustration (Fig. 1), which shows a furnace specially designed for melting brass swarf, it will be seen that the furnace bottom is supported at a height somewhat greater than that of the refractory crucible. The circular platform (A) is in the form of a hollow or box-like disc, having a central opening (B). Upon the platform are two concentric cylindrical shells (D, E), the platform being so formed that the annular space between these shells communicates with the hollow interior of the platform, one or more of the columns (C) forming a connecting passage or passages, as the case may be, from the interior of the platform to the flue or duct. The outer shell is extended somewhat above the inner, and provided with an upper cap or cover (F), from which depends the hopper-ended tube (G), for the reception of the brass swarf. The central opening (B) in the supporting platform is closed by a cover or disc, supported upon a column (H) working in a guide (J), which, if desired, may take the form of a hydraulic cylinder suitably fitted for raising or lowering the column.

When the crucible is in the position shown, the end of the feeding tube dips about half-way into it. The length of the column of swarf is so proportioned as to be substantially balanced by the head of molten metal between the bottom of the shute and the top of the crucible, thus eliminating the possibility of the metal overflowing.

To empty the crucible or remove the slag and other impurities therefrom, the column carrying the crucible is lowered, care of course being taken that the feeding-pipe is empty before operating the column. Provision is also made for carrying on the melting as a practically continuous process, for which purpose a crucible having an outlet at the bottom is provided, supported upon a column having a passage-way which allows the removal of a plug from, or its insertion in, the outlet of the crucible. The annular space between the bottom of the crucible and the inner shell of the furnace may then be closed by radially-movable doors, formed so as to fit together and provide a solid bottom to the furnace chamber.

The patentee of the furnace illustrated is Mr. Alexander C. Ionides, Porchester Terrace, London, W., and the manufacturers are Complete Gas Combustion, Limited, Vickers House, Broadway, Westminster.

A FOUNDRY IN THE WAR AREA.—A correspondent writing from the firing line in France says:—One does not see much foundry work out here, but a few weeks ago I was billeted in a town near by, and actually saw a cupola in full blast. I at once got permission to have a look round, and was greatly surprised at what I saw. The foundry was a very primitive affair—just a little jobbing shop—and was mostly run by French women and girls, superintended by a few R.E. men. These women were making work up to 3 and 4 cwts. in weight, and in a little side shop some half dozen women were making component parts of machinery by the simple method of bedding-in. I afterwards saw some of the finished work, and it would put to shame the work done by many of our so-called moulders at home. The women work in ordinary dress, and work very clean and exact in both iron and brass, and also under shell fire and air raids. In the middle of the shop was a great hole where a German had dropped a big bomb the night before, but the women still carried on.

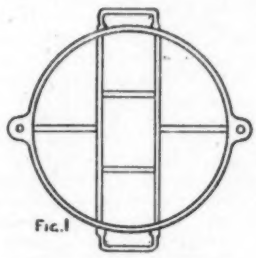
Moulding Pistons for Pneumatic Brakes for Railways.

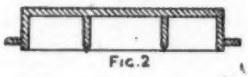
By A. B. Smith.

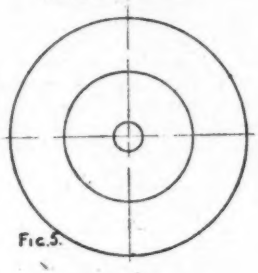
The following is a description of the tackle used and the method of moulding the above. Up till a recent time the writer saw them being made by the old-fashioned three-part method of solid pattern and loose ring, the rate being about nine a day. By the following method a man and two boys would produce about 35 to 40 of the 18-in. size per day.

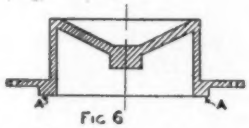
Moulding Boxes.

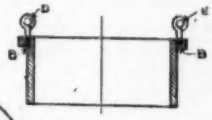
Figs. 1, 2 and 3 show the class of box used, both elevation and section. These boxes should be turned on the edges and lugs drilled to a matrix to allow of duplicating. The stays in Fig. 1 are shaped to form a square in the centre, the reason for which will be explained later. The top box is exactly as the bottom, but the bars may be cast flat if desired in the bottom box. The middle box, Fig. 3, must be the exact depth of the casting from top flange to inside of bottom flange, see Fig. 9 or Fig. 7, ring pattern.

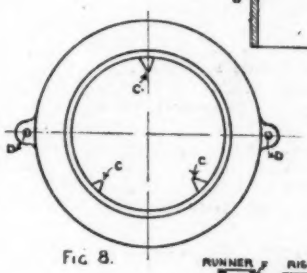


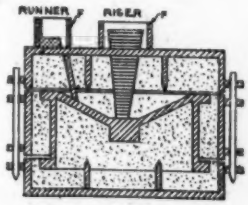












Patterns.

Figs. 4 and 5 show a plate pattern which forms the top mould, an ordinary cast plate and turned inside. Fig. 6 is the bottom plate. This is machined inside, and forms the bottom flange at A. Fig. 7 shows the ring pattern. This is machined on the outside, and at the same time forms the top flange at B, B. Fig. 8 is a bottom plate with three studs at C, and is machined to form a fitting for the ring, Fig. 7, and to carry the centre box.

Moulding.

If an ordinary turnover moulding machine is available, this is of great advantage in making the bottom mould, as it ensures a straight draw—a very essential point. If this is not available, then the following method is adopted:—Place a middle box part on the floor, then place the plate pattern, Fig. 6, in it; next place the bottom or drag box in position by means of the pins and lugs. Put on a good sifting of facing sand and ram up in the usual way. After striking off the superfluous sand and well venting, turn the whole over on to a bed. Rap the plate all round and withdraw the plate pattern. Finish off in the usual manner and dust on a small amount of plumbago.

Now to proceed with the middle mould, place the pattern plate on a bed and put in position the ring pattern, Fig. 7; this is kept central by the studs, C, Fig. 8. Now place the middle box, Fig. 3, on the plate, this being guided on by the pins, D, Fig. 8. Now ram up and finish off lightly. When nearing the top, strike off level and sleek with a trowel. This pattern is loosened by rapping inside and withdrawn by means of the screws, Fig. 7, D and E, after which the mould is lifted and placed on the bottom mould.

The top mould is made next. Place the pattern plate, Figs. 4 and 5, either on a box part or bed. Place the top box, Fig. 2, in position. Next place a riser pin on the boss as at Fig. 9, as this must be very clean and sound for machining. Ram up in the same manner as before and give a good venting. After rapping the outside edge the mould can be either lifted off or rolled over and pattern withdrawn. The gate is formed by pushing through the top mould a ¾-in. tube. Place the mould in position as in Fig. 9, placing on runner and riser boxes as at F, and secure by cotter pins.

Fig. 9 shows the completed mould and casting in position, also the method of running and rising. These castings, made on a repetition system, two lads making tops and middles and a moulder making bottoms, should be made at the rate of quite 45 to 50 in a 9-hours day.

Electric Furnace Operating Costs.*

By T. T. Snyder.

When selecting the type of electric furnace to be used there are five items of expense in furnace operation that have to be considered, viz.:—(1) Cost of electrodes, (2) cost of refractories, (3) cost of electricity, (4) cost of labour, and (5) maintenance, depreciation, and investment charges.

Electrode Cost.—The electrode costs the user in two ways—viz., by the burning away and by the heat which it conducts out of the furnace. The sum of these items for a well-designed furnace melting 1,000 tons of steel a month represents some £1,200 a year per electrode. With capital worth 20 per cent. a year the elimination of one electrode would justify an investment of £6,000. The ideal furnace would have no electrodes, and the induction furnace met this requirement, but unfortunately introduced defects which hamper its commercial success. By using the metal bath in the furnace as one terminal of the arc, a furnace can be operated with one electrode per arc. As three-quarters of the cost of each electrode is due to surface burning, the smaller the electrode the lower will be the electrode cost. The size of the electrode is determined by the current, and this (and the size) will be smaller, the higher the voltage between electrode and bath. The voltage is limited by a roof condition; silica bricks used for roofs are fairly good electrical conductors at white heat, and at steel finishing temperatures the furnace gases are also rather good conductors. When current is switched on the arc will jump a considerable distance, which limits the pressure between a single electrode and the bath to about 220 volts.

If two or more electrodes are used through the same roof, experience shows a limit of 110 volts between electrodes to avoid breakdown roof leakages; that is for two electrodes, 55 volts between each electrode and the bath. With the same energy input each of the two electrodes has, therefore, to have double the cross section of the single electrode with the higher voltage, or a combined cross section four times as great, and therefore four times the heat losses of an equivalent single electrode, and three times the sum of heat losses of the single electrode and a contact to the bath. The burning surface of the two electrodes is double that of a single one, and the equivalent cost of two electrodes with two arcs in series, on the basis of 1,000 short tons (2,000 lbs.) of steel a month, is £2,700 a year, as compared with £1,500 for one electrode and its contact. If three electrodes are used through the same roof, so as to introduce directly three-phase current into the furnace, the limiting voltage is usually kept at about 110, and this results in a potential of about 65 volts between electrode and bath. With the same total input each electrode will carry one-third of the energy of a single electrode at about one-third of the voltage, and therefore each electrode will carry the same current as does the single electrode, and be the same size, the three having heat loss and surface burning equal to three times those of a single electrode. Thus for 1,000 tons of steel per month, the electrode cost for three electrodes will be £3,600, as against £1,500 for a single electrode and contact.

Refractories Cost.—The bulk of the refractory cost is due to roof wear, and the roof wears most around each electrode. The cost figures from different furnaces show a total refractory cost for three-electrode furnaces of substantially three times the total refractory cost for single-electrode furnaces. With a well-designed furnace melting 1,000 tons of steel a month, this refractory cost may be kept down to £800 per electrode per year.

It is the maximum temperature at the end of the heat that wears the refractories in a steel furnace. The energy absorbed by the roof and walls in a well-designed furnace amounts to less than 10 per cent. of the total power input. The energy to be radiated per sq. in. of arc surface determines the temperature to which the arc must rise to get rid of energy at the input rate. The three-electrode arc voltage is 65; the single-electrode arc voltage is 220; and in each case about 35 volts are absorbed by the arc terminals. This leaves 30 volts per arc to determine the length of each of the three arcs of the three-electrode furnace and 185 volts for the single arc of a one-electrode furnace. Therefore, the total length of the single arc is more than twice the sum of the lengths of the three arcs. As this single arc has consequently to radiate only half the energy per sq. in. it will be cooler than each of the three arcs.

Electricity Cost.—The molten metal poured into the ladle, the hot slag, and the gases given off during melting, contain a definite amount of energy, approximating 350 kw.-hours per 2,000 lbs. of steel. There are also direct losses by radiation through the furnace shell and the heat loss through the electrodes, which go on continuously after the furnace is heated up, and would represent about 120 kw. continuously in a furnace producing 1,000 tons of steel per month. If the furnace input were 240 kw.-hours, only 120 kw.-hours would be available for steel melting, at which rate it would take about three hours per ton melted, and 360 kw.-hours of heat energy would be lost, making a total energy consumption of 360 plus 350 or 710 kw.-hours per ton of steel. If the furnace were given an energy input of 820 kw. the net energy available for melting after losses were supplied would be 700 kw., which would melt the ton of steel in half an hour, during which time the heat losses would only be 60 kw.-hours, so that the total energy for melting would be 410 kw.-hours per ton.

It is evident that the higher the energy input the higher will be the heat efficiency. With a three-electrode furnace the limit is soon reached, owing to lack of room to space the electrodes far enough apart to prevent current leakage through the roof. The insulation of the roof bricks can be improved by water cooling, but the heat lost to the water is greater than the heat saved by increased energy input. Increasing the energy input does not necessarily result in higher furnace temperatures; the latter are determined by the melting point of the metal, and cannot rise above the melting point of steel, so long as there is unmelted metal in the furnace. With a single-electrode furnace no limit has been found to the rate at which power can be put into a furnace and the efficiency correspondingly raised if certain simple metallurgical precautions are taken. If energy is put in faster than the steel can be

* "Electrical Review," U.S.A.

"killed" after the steel is melted, the excess only operates to raise the temperature and melt the walls. To permit a high rate of energy input the "killing" must be speeded up. Air leaks through furnace doors prevent this; the air burns up the electrode, oxidises the steel, and carries away heat in escaping. The value of the heat loss for each door of the sliding type has been determined at some £300 a year. Two ordinary doors may easily double the time required to finish a heat.

As it is in practice almost impossible to keep a door tight, the difficulty can be overcome by having a doorless furnace, with a tilting roof to admit the charge. Any piece of scrap that the furnace will hold can be put in through the roof, while the scrap has to be cut to enter a door. The heat loss in opening up a roof is found to be much less than through a single door.

Labour Cost.—The open roof furnace can be more easily charged, and such a furnace can be operated by one melter and a helper, or, if of less output than 500 tons a month, without a helper. A single high-voltage electrode is lighter to handle and requires less time for adjusting than three electrodes: high voltage has another advantage, as with a single-electrode arc about 185 volts are available for arc length, which gives an arc about 5 in. long, and the rising of a slag bubble ¼ in. reduces the arc resistance less than 20 per cent., whereas the 90 volts available in a 65-volt three-electrode arc only allows of ¼ in. arc length, so that each time a slag bubble comes up under an electrode, the power load is short-circuited in the arc. For this reason the boiling of the bath does not take any of the melter's time with a single-electrode furnace, but takes all the time of one man with a three-electrode furnace. To overcome this difficulty three-electrode furnaces are provided with automatic regulators, which, however, have yet to demonstrate their value as labour-savers.

A doorless single-electrode furnace only uses 1-12 the weight of the electrode per ton of product used by a three-electrode door-type furnace, and this represents a substantial saving in labour in handling; the roof with one electrode hole also lasts longer, and these items, summarised, mean that some £800 a year will be saved in labour cost in producing 1,000 short tons of steel a month in a single-electrode doorless furnace.

Maintenance, Depreciation, and Interest Charges.—The three-electrode equipment is obviously more costly in maintenance and depreciation than the single-electrode equipment. As the single-electrode furnace can be operated at double the speed, the original investment and interest on first cost are also less. With 1,000 tons output per month, the difference due to these items will reach £1,200 per year. Summing up the various items in favour of the single-electrode furnace for the output assumed, the total saving will reach £7,300 a year. As a well-designed furnace requires an energy input of about 800 kw. for an output of 1,000 tons of steel per month, this saving equals £9 per year per kw.

The Open Riser.

By "Moulder."

In every foundry the old question, as to whether a riser is best left open or closed, is brought out for discussion at some time or other. Opinions differ as to what happens when the riser is left open, to produce the bad results attributed to this cause. A great deal depends on the type of casting and the speed at which the mould is filled, as a large variety of castings may be run without risk without closing the risers; while at the same time a mould which has the risers closed as a precaution will, if the casting be run short, suffer damage to the top part. This would occur even if the job were run at the bottom, with no chance of "drawing air," as it is called, which is really an escape of air and gases produced in large volumes when the metal touches the sand. By filling slowly, any mould of large size and cope surface area, unless there are a number of cores to protect the cope from the heat of the metal during the greater portion of the filling period, can be made to "pull in," as it is termed, even without risers on the job. The strength of the sand and the method of reinforcing that strength by gaggering, sprigging and drying will certainly influence results in any mould. There would appear to be no difference between the dropping of a top exposed to the radiant heat of metal for a long period of time without support, and the dropping of a top hung over a fierce fire to dry, also without support. Many moulders will have seen this, and as a protection against overheating the face and thereby producing unequal expansion and consequent peeling, will cover the fire with a plate or piece of sheet iron, this also preventing burning which would likewise cause dropping of the top.

It is certainly not advisable to leave the risers open on every mould, the majority being kept closed, as the fact of closing them gives the vents the chance of fulfilling their proper function, and in addition to this it is undesirable to have a strong current of hot gases, induced by the rapidity of production and expansion, tearing through a mould, with the probability of detaching corners and blowing away vent seals and connections, instead of escaping by the proper outlets—the vents—in a much milder manner. Another effect which is no doubt caused by closed risers is the retention of a dense volume of gas between the rising metal surface and the cope. This is much more effective in the case of a deep mould than in a shallow one, gases being bad conductors of heat, a thick layer in the former naturally giving more protection than the thin layer in the latter case. The presence of this gas is sometimes shown in a mould having a deep, hard, or badly vented cope with snugs or brackets projecting into it and not provided with risers; and the resistance it offers, being compressed and with no means of escape, is such at times as to prevent complete filling of these parts. For this reason, with deep copes, it is advisable to put dummy risers on such places to prevent such an occurrence.

MELTING POINTS OF FIREBRICKS.—The melting point of a firebrick is understood to be the lowest observed temperature at which it exhibits transition from a rigid to a fluid state. Mr. William M. Barr, in "Industrial Engineering," states that the melting points of forty-five samples of firebrick, including fireclay, bauxite, silica, magnesia and chromite brick, have been determined in an electric vacuum furnace, the temperature being measured with an optical pyrometer, and the following melting points were determined:—

	Deg. Cent.
Kaolin	1,740
Pure alumina	2,010
Pure silica	1,600
Bauxite	1,820
Bauxite clay	1,795
Chromite	2,180
Magnesite brick	2,165

Lead Order.

In an Order dated September 1, 1917, the Minister of Munitions gives notice as follows:—

(1.) He hereby takes possession as from September 1, until further notice, of all pig-lead, whether virgin or remelted, old and scrap lead and lead residues, now or hereafter situated in the United Kingdom, subject to the following exceptions:—(a) All such lead as may be in the possession of or due under an existing lawful contract in writing for future delivery to a manufacturer for use in such manufacturer's own works. (b) All such lead as may be specially excepted under the written authority of the Minister of Munitions.

The lead of which possession is taken as aforesaid will, until further notice, be paid for by the Minister of Munitions on delivery, as to virgin pig-lead at the prices specified in the schedule hereto, and as to remelted, old, and scrap lead and lead residues upon terms which will be communicated in due course to the various owners.

(2.) If any person having control of any lead of which possession has been taken under clause 1 hereof, without the consent of the Minister of Munitions sells, removes or secretes it or deals with it in any way contrary to any conditions imposed in any licence or permit that may be granted in respect thereof, he will be guilty of an offence against the Defence of the Realm Regulations.

(3.) All existing licences issued by or on behalf of the Minister of Munitions for dealing in any remelted, old, or scrap lead or lead residues are hereby cancelled.

(4.) No person shall as from the date hereof until further notice purchase, sell, offer to purchase or sell, or, except for the purpose of carrying out a contract in writing existing prior to April 6, 1917, for the sale or purchase of white lead, lead oxides, lead manufactures, lead alloys, or lead compounds of any kind, or a contract in writing existing prior to February 2, 1917, for the sale or purchase of any other kind of lead, enter into any transaction or negotiation in relation to the sale or purchase of lead situated outside the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

(5.) No person shall as from the date hereof until further notice offer to purchase, purchase or take delivery of any lead situated in the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, or offer to sell, sell, supply, or deliver any such lead to any person other than the holder of such a licence, and in accordance with the terms thereof, provided that no such licence shall be required in the case of any offer to sell or purchase, sale, purchase, or delivery of such lead:—(a) For the purpose of a contract or order for the time being in existence, certified to be within Class "A" in the Order of the Minister of Munitions as to priority, dated March 8, 1917, and made in substitution for Circular L.33, or certified by or on behalf of the Minister of Munitions to be within Class "B" of the said Order. (b) For the purpose of necessary repairs or renewals requiring immediate execution, and for which no other metal can be substituted, and requiring for the entire carrying out thereof the use of not exceeding 1 cwt. of sheet lead or lead pipe, and not exceeding 28 lb. of solder and no other lead, and in respect of which repairs or renewals the purchaser shall have given to the seller at or before the time of purchase a declaration in writing specifying the nature of the work for which the same is required, and the place where the same is to be carried out, and that the lead purchased is for the purpose mentioned in this sub-clause, and for no other purpose.

(6.) No purchase or sale of lead situated in the United Kingdom, or offer to purchase or sell any such lead, whether such purchase, sale, or offer is, or is not, under any licence issued under the authority of the Minister of Munitions, shall, in the case of any class of lead specified in the schedule hereto, until further notice be at a price exceeding the price set opposite the same in the said schedule.

(7.) No person shall, as from the date hereof until further notice use any lead for the purpose of any manufacture or work except:—(a) For the purpose of a contract or order for the time being in existence certified to be within Class "A" of the Order of the Minister of Munitions as to priority dated March 8, 1917, and made in substitution for Circular L., 33, or certified by or on behalf of the Minister of Munitions to be within Class "B" of the said Order. (b) For the purpose of necessary repairs or renewals requiring immediate execution and requiring for the entire carrying out thereof the use of not exceeding 1 cwt. of sheet lead or lead pipe, and not exceeding 20 lbs. of solder, and no other lead. (c) For the purpose of type-casting from metal already in the form of type on February 2, 1917, or from lead purchased for that purpose prior to that date. (d) Under and in accordance with the terms of a licence issued under the authority of the Ministry of Munitions.

(8.) All persons shall, within seven days from the first day of each month, send in monthly returns of:—(a) All lead held by them in stock or otherwise under their control on the last day of the preceding month, the lead actually in stock to be shown separately. (b) All lead purchased or sold by them for future delivery and not yet delivered on such last day. (c) All lead delivered to them during the preceding month. (d) All contracts or orders existing on the last day of or entered into during the preceding month requiring for their execution the use of lead for any purpose specifying the amounts of lead required monthly for the purpose of such contracts or orders, and distinguishing between the amounts required for, work certified to be within Class "A" in the said Order of March 8, 1917, and the amounts required for other purposes, or certified by or on behalf of the Minister of Munitions to be within Class "B" of the said Order.

Notwithstanding the above no return is required from any person whose total stock of lead in hand and on order for future delivery to him has not at any time during the preceding month exceeded 1 cwt. Returns shall, as regards remelted, old, and scrap lead, and lead residues be sent in to the Director of Materials, AM2/ES, Hotel Victoria, Northumberland Avenue, London, W.C. 2, and as regards all other kinds of lead, to the Director of Materials, AM2/E Hotel Victoria, Northumberland Avenue, London, W.C. 2.

(9.) For the purpose of this Order the expression "Lead" shall mean pig lead, whether virgin or remelted, sheet lead, lead pipe, and old and scrap lead, lead residues, white lead, whether dry, in oil, or prepared for use, lead oxides, lead manufactures, lead alloys, and lead compounds of every kind, or any of them.

(10.) All communications on the subject of remelted, old or scrap lead, or lead residues, and all applications for licences to purchase lead other than remelted, old or scrap lead or lead residues, shall be made to The Director of Materials, AM2/E, Hotel Victoria, Northumberland Avenue, London, W.C. 2, and marked "Lead Licence." All applications to use lead other than remelted, old or scrap lead or lead residues shall be made to The Controller, The Priority Department, 1, Caxton Street, Westminster, S.W. 1.

Schedule of Maximum Prices.

Virgin Pig Lead:—£29 per ton c.i.f.; £30 per ton ex store; or ex refiner's works.

Manufactured Lead:—Sheet Lead, £39 10s. per ton; Lead Pipe, £40 per ton. Delivered United Kingdom, less 2½ per cent. monthly account, the usual trade extras and allowances to apply.

The rate of exchange between chemical houses and manufacturers of chemical sheet lead, for the old lead in pig-lead shape, to be £8 per ton for sheet lead, and £8 10s. per ton net for lead pipe, the manufacturer paying cost of delivery of the old lead; the sheet lead or lead pipe to be delivered United Kingdom. The usual trade extras to apply.

The Allen-West Lifting Magnet.

The duties to which lifting magnets are subjected make it necessary that they should be practically indestructible; the lifting efficiency must be high whilst the dead-weight of the magnet must be kept as low as possible. It should be recognised that the cost of the current for a magnet is a relatively small item in the total cost of handling iron and steel, the saving to be effected by having fewer trips and lifts, and the economy of time and labour with a large-current magnet showing considerable economy over those of the low-current type. The lifting capacity of a magnet depends, of course, on the product of the current and the number of turns of the winding, *i.e.*, with the proper design of steel casting the lifting capacity will increase as the number of ampere-turns is increased. For a given coil the greater the current passed, the greater the attractive force, as it may be taken as an axiom that the attractive force rises as the square of the flux density. By increasing the current carried in the magnet coil to a safe maximum, so that over-heating is prevented, and by a scientific arrangement for winding the maximum number of turns in the least possible space, it is possible to obtain the highest lifting efficiency.

From time to time many home-made lifting magnets have been constructed, and on certain classes of load, for a time at any rate, have given useful service. Sooner or later, however, trouble has arisen due to the severe service and exposure, whilst even whilst at work the efficiency has been relatively low, owing to inadequate arrangements for winding and assembling. It is obvious that to produce apparatus of this nature a special plant and adequate means of testing the various component parts and the complete unit are a *sine qua non*.

FIG. 1.—SHOWING DETAILS OF CONSTRUCTION.

FIG. 2.—SHOWING MAGNET COMPLETE.

THE ALLEN-WEST LIFTING MAGNET.

Our representative had an opportunity recently of seeing an Allen-West magnet on test at the Brighton Works of Messrs. Allen West & Company, Limited, and as this embodies some novel features a description will no doubt be of general interest. The frame is of high-permeability steel, the rim

being corrugated with ribs so arranged that recesses are formed for protecting the heads of the bolts holding the outer pole shoes. Three-point suspension is adopted, the lugs being cast integral with the frame. The plate on the bottom of the magnet is made of a stout disc of manganese steel, heavily ribbed on the under-side. This material, apart from its remarkable strength, is also non-magnetic, and is therefore ideally suited to withstand the heavy blows, and to separate the inner and outer poles.

The coil is of "pancake" construction, wound in four layers. A unique feature, which is shown in Fig. 3, is the method of winding adopted to secure a rigid coil. A slight recess is rolled on the copper strip as winding proceeds, and as the recess on one turn registers with the recess on the previous turn, with a flexible insulated ribbon between, an extremely rigid coil results. On completion of the winding a very strong metal sleeve holds the coil tightly, so that distortion or damage under the most trying conditions is practically impossible. The spool on which the windings are mounted is of magnetic material; thus all the interior metal is active magnetically, while the length of mean turn of the winding is not increased as in the case of magnets using spools of non-magnetic material.

It will be noted that the interior of the magnet is arranged so as to eliminate pockets of dead air, and to conduct the heat of the windings rapidly to the case, where it is dissipated to the atmosphere. The terminal box is of particularly robust construction; connections from the coils are brought to heavy studs fitted in a chamber which is readily accessible from outside by removing the steel plate. These studs project through a boss on the main casting, from which they are insulated, to the connection chamber. The massive cover-plate fits over this chamber (which should be filled with compound), and water-tight glands prevent the ingress of water or moisture. A special

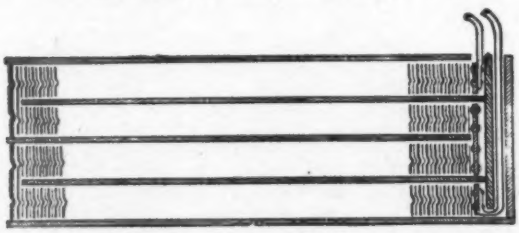


FIG. 3.—METHOD OF WINDING LIFTING MAGNET.

feature of the box is a coned collar for anchoring the armour of the incoming connecting cable, whilst flanges on the frame protect the box and cover from side-blows.

Obviously, special steps are necessary to render the magnet quite water-tight; the presence of moisture has in the past been the cause of a large amount of trouble with lifting magnets.

The magnet under consideration is assembled with coils, etc., in position. The interior is then exhausted by means of a powerful vacuum pump, the magnet at the same time being heated, so that any moisture retained in the interior is turned into steam and drawn off through the vacuum pump. When the exhausting process has been completed the insulating compound is admitted into the hot airless interior of the magnet under a pressure of 120 lbs. to the sq. in., so that it permeates every part of the interior. The compound hardens to a strong elastic substance. Magnets so treated may be, and indeed are, used under water without injury.

For limiting the induced voltage and dissipating the energy which follows the opening of the circuit of the lifting magnet, a non-inductive resistance is shunted across the terminals of the magnet prior to opening the circuit. This resistance is disconnected when the circuit is re-established. To overcome the effect of residual magnetism, which causes the load to adhere to the magnet for a few seconds after the current is cut off, a small current in the reverse direction is passed through the magnet, which is thus de-energised. This reverse current will, however, only pass while the drum is held on the "quick-drop" position, the controller being returned to the "off" position when the handle is released. A mechanical stop prevents overthrowing. The controller fingers are of the hinge type, the copper tip being fastened to the finger by a stud and nut with lock washer. The finger is heavily shunted, so that the hinge and spring do not carry the current. The blow-out arm is made to swing back, so that all parts are accessible, and is so arranged that the circuit is always broken in a concentrated field. The arc shields are on two supporting rods, the whole shield being insulated with mica.

Dealing with the magnet under test, these tests are conducted in the impregnating shop, which has been especially equipped for this purpose. The plant comprises the usual steam-heated mixer, with exhauster and pressure-pump combined, also a motor-generator for heating the magnet windings. The insulation test consists of a flash 1,500 to 2,000 volts for one minute.

It is interesting to note that the magnet under test at our representative's visit was heated up to 560 deg. Fah., the temperature being maintained for a period of six hours, and after cooling down the insulation was found to be entirely unaffected, the whole magnet remaining in perfect condition.

GROWTH IN BRITISH STEEL PRODUCTION.—In the course of a speech in the House of Commons recently, on the Vote for the Ministry of Munitions, DR. ADDISON remarked that the output of steel in this country had been more or less stationary for some time—at a little over 7,000,000 tons per annum. The output was now about 10,000,000 tons, and he would be much disappointed if, with the great schemes which are now being worked at, a 12,000,000 ton output was not reached by the end of next year. Increased production of basic steel from home ores should provide us with the capacity for the production in this country by the spring of next year of an additional one-and-three quarter million tons of basic steel above our previous home production. Within about fourteen months from the commencement of the scheme, we should have increased our home capacity for the manufacture of basic steel by 30 per cent. Notwithstanding the costs of material and labour, we were obtaining steel plates in this country at less than half their cost in the United States, where shell steel also cost 30 per cent. more than it does at home. The production in this country before the war of spelter or commercial zinc was only about one-third of our national requirements. Before the end of the present twelve months he hoped that we should have doubled that capacity. Works had been established in this country for the production of tungsten which enabled us fully to meet our own requirements, and to supply much besides to our Allies.

Personal.

MR. G. MURE RITCHIE has resigned as a director of the Cargo Fleet Iron Company, Limited.

MR. ROGER BECK, of Baldwins, Ltd., has given £10,000 towards a new orphanage at Swansea.

LIEUTENANT T. L. WARD, the eldest son of Mr. T. W. Ward, of Sheffield, has been promoted captain.

THE late Mr. William Musgrave, engineer, of Croftlands, Grange-over-Sands formerly of Bolton, left £119,771.

THE late Mr. B. G. Wilmer, of Bury Street, St. Mary Axe, London, ironfounder and iron merchant, left estate valued at £46,492.

THE late Mr. B. Hall Blyth, of Edinburgh, partner in the firm of Messrs. Blyth and Westland, civil engineers, left estate to the value of £31,311.

CAPTAIN HAROLD STEEL, a director of Messrs. John Kenyon & Company, Limited, of Sheffield, has been promoted to the rank of major.

THE late Mr. J. R. Porter, of the firm of Whittingham & Porter, general engineers, Victoria Ironworks, East Hull, left estate valued at £10,405.

THE gross value of the estate of the late Mr. W. H. Holden, sales superintendent of the North Lonsdale Iron and Steel Company, Limited, is £3,125.

THE late Mr. George Pyper, managing director of Lawson, Turnbull & Company, Limited, metal merchants, left personal estate of the value of £17,428.

MR. H. H. HUGHES has resigned his position with the Mond Nickel Company, Limited, and is now London manager for J. H. Dennis & Company, Limited.

SIR THOS. BELL has, at the request of the Government, joined the Admiralty, and has temporarily resigned his seat on the board of John Brown & Company, Limited.

THE gross value of the estate of the late Mr. H. S. Jefferies, a director of Ransomes, Sims & Jefferies, Limited, of Ipswich, is £66,491, of which £59,254 is net personalty.

THE late Mr. W. S. Laycock, head of W. S. Laycock, Limited, and Cravens, Limited, Sheffield, manufacturers of railway material, left estate to the value of £71,145.

SIR R. SOTHERN HOLLAND and Sir H. Ross Skinner have been transferred from the Ministry of Munitions to the Admiralty for special work in connection with the Board of Invention and Research.

THE late Mr. W. D. Cliff, of the Towers, Meanwood, Leeds, and chairman of the Frodingham Iron and Steel Company, Limited, and the Micklefield Coal and Lime Company, Limited, left estate valued at £229,380 gross, with net personality £171,885.

THE late Mr. C. A. Bleckly, manager of the London branch of the Pearson & Knowles Coal and Iron Company, Limited, and the London agent for Ryland Brothers, wire manufacturers, Warrington, and the Staveley Coal and Iron Company, Limited, left estate of the value of £29,951.

THE Deputy Controller for Auxiliary Shipbuilding, Admiralty, has appointed Lieutenant-Colonel J. Mitchell Moncrieff to be Director of Engineering Work, to deal generally with all civil engineering matters which may arise in connection with his department. Lieutenant-Colonel Moncrieff is a member of the Institution of Civil Engineers, and has carried on an extensive practice as a consulting engineer.

THE MINISTER OF NATIONAL SERVICE has appointed Mr. E. A. Sandford Fawcett to be the Secretary of the National Service Department. In normal times Mr. Fawcett is the Deputy-Chief Engineer of the Local Government Board, but since the commencement of the war he has acted as a special investigator for the Ministry of Munitions, as Secretary to the Man-Power Distribution Board, and as Chief Assistant to the late Director-General of National Service.

The following appointments have been approved by the Minister of Munitions:—Colonel W. C. Wright to be Controller of Iron and Steel Production in the place of Sir John Hunter, K.B.E., appointed a member of the Council. Major A. Corbett to be Controller of Explosives Supply, in place of Sir Keith Price, appointed a member of the Council. Major J. H. M. Greenly to be Assistant Controller of Administration in the Inspection Department in place of Sir H. Rose Skinner. Sir Leonard W. Llewelyn, the Deputy Director-General of Materials Supply, will in future be known as Controller of Non-Ferrous Materials Supply.

A STATEMENT has been issued by the Ministry of Munitions, to the effect that the functions of the Finance and Contracts Departments of the Ministry have been rearranged. Mr. J. Mann, chartered accountant, has been appointed Controller of Munitions Contracts. Mr. Mann has hitherto, in his former office, negotiated special contracts, and this sphere of duty has now been extended to include the negotiation of contracts of all classes. Mr. S. Dannreuther, C.B., has been appointed Controller of Munitions Finance. Mr. J. E. Masterton Smith, C.B., principal Private Secretary to the First Lord of the Admiralty, has been appointed to be Assistant Secretary of the Ministry.

SIR ARTHUR WHITELEGGE, K.C.B., who has held the appointment of His Majesty's Chief Inspector of Factories and Workshops at the Home Office for more than 21 years, will retire in the course of the next month on reaching the age of 65, and the Home Secretary has appointed Mr. H. M. Robinson, the Senior Deputy Chief Inspector, to succeed him. An arrangement has been made by which Sir Arthur Whitelegge will continue to give his services to the Factory Department in an advisory capacity on questions of a technical and scientific character. Mr. R. E. Graves, the Junior Deputy Chief Inspector, will now become the Senior Deputy Chief Inspector; and Mr. Gerald Bellhouse, Superintending Inspector of Factories, has been appointed Junior Deputy Chief Inspector.

Legal.

Tin Exports to Sweden.

At Westminster, on September 10, J. V. Cronquist, of Palace Chambers, Bridge Street, was summoned for giving false particulars in an application for a licence to export prohibited goods. Mr. Travers Humphreys said Cronquist made application to export 15 tons of ingot tin, worth £3,500, to Stockholm, and he mentioned that, owing to shortage, the Germans would pay any price for such material. Cronquist gave the name of a person in Stockholm as the ultimate consumer of the tin, but he was only acting as an agent, and there was no firm order at all, simply negotiations with the agent. The magistrate said he regarded the case as a very serious one, and fined Cronquist £300, with £15 15s. costs.

£100 Fine for Using Copper.

At Birmingham, last month, the Parkinson Stone Company was fined £100 and costs for using copper in the manufacture of certain geyser and water heaters, contrary to the Regulations of the Minister of Munitions. Defendants had executed eighty-one orders between December and February without a certificate of any kind. It was stated that only about one permit out of every hundred applied for was being granted.

BRITISH FOUNDRYMEN'S ASSOCIATION: LONDON BRANCH.—The honorary secretary of this Branch, Lieut. Alexander Hayes, R.N.V.R., having been compelled to relinquish the position, owing to pressure of service duties, Mr. Jas. Gaunt, 11, Sedgemore Avenue, East Finchley, London, N., has kindly consented to act as secretary for the present. Mr. Gaunt was elected a member of the General Council of the Association at the recent annual meeting, and has proved an enthusiastic worker in the interests of the branch.

Trade Talk.

A NEW blast furnace is now in course of erection at the Devonshire works of the Staveley Coal and Iron Company, Limited.

THE offices of the Hoyt Metal Company, of Great Britain, Limited, have been removed to 189, Hammersmith Road, London, W. 6.

A STEEL furnace has been added to the plant of the Sheepbridge Coal and Iron Company, Limited, and is ready to be put into operation.

A FIRE broke out at the Little London Works, Sheffield, of Tyzack, Sons, & Turner, Limited, September 25, but the damage was light.

MESSRS. D. P. OAKLEY and J. H. TAYLOR, odd ironwork manufacturers, etc., Lye, trading under the style of Oakley & Taylor, have dissolved partnership.

THE temporary address of the engine works department of Sir W. G. Armstrong, Whitworth & Company, Limited, is Albert Chambers, 13, Bath Street, Glasgow.

MESSRS. S. C. FILDES and A. C. FILDES, engineers' small tool manufacturers, Greenodd, near Ulverston, trading under the style of Fildes Bros., have dissolved partnership.

THE partnership heretofore subsisting between Messrs. A. Greaves and A. J. Owen, iron founders, 55A, Church Road, Redfield, Bristol, trading under the style of Greaves & Co., has been dissolved.

MESSRS. WM. DENNY & BROTHERS have secured the sanction of the Dean of Guild Court at Dumbarton to their petition for the erection of a large brick building in the Leven Shipyard, to be 240 ft. long by 60 ft. wide by 30 ft. high.

A LONDON syndicate is reported to have opened negotiations with Lord Treowen, owner of the Llanarth Estate, for the acquisition of land on the western bank of the River Usk at Newport, as a shipyard site for the construction of standard vessels.

Messrs. J. Ingham, G. H. Ingham, H. Ingham, T. Ingham, J. Ingham, jun., and H. Ingham, mining tool manufacturers, Middlestown, trading under the style of John Ingham & Sons, have dissolved partnership. Mr. John Ingham continues under the same style.

THE partnership heretofore subsisting between Messrs. W. S. Wilkins and T. Mitchell, carrying on business as engineers and machine tool makers, at the Green, Darlaston, under the style of Wilkins & Mitchell, has been dissolved. Mr. Wilkins continues.

THE SHIPBUILDERS' CORPORATION of Toronto, Ontario, has been formed with a capital of £50,000, and the Godorich Dry Dock and Shipbuilding Company, Limited, with a capital of £200,000. Construction has been commenced at Toronto on vessels for the Imperial Munitions Board.

IT is understood that the negotiations for taking over the old South Wales and Risca Wharves, near the Town Dock, Newport, for the purpose of laying down a shipbuilding yard, are practically completed. At present the syndicate promoting the scheme is desirous of also leasing a strip of land to the north, but adjoining the present wharves. It is proposed at the outset to lay down four slips.

STEPS will shortly be taken to lay down a new shipyard at the east end of Dundee harbour by the Caledonian Shipbuilding and Engineering Company, Limited. The company has at present a shipbuilding yard and foundry, but the new shipyard will be on a much larger scale. The Dundee Harbour Board have sanctioned the leasing to the company for twenty years of over 14 acres of land for this purpose.

THE Syllabus Committee of the West of Scotland Iron and Steel Institute, finding increasing difficulty in obtaining interesting papers and lectures during the present abnormal times to enable a full series of meetings to be held during the approaching session, have decided to invite those members who may have time and material available to contribute papers, however brief, which may be expected to lead to useful discussion at the meetings.

THERE is every prospect of success attending the negotiations with the Swansea Harbour Trust for the provision of a new dry dock at the Prince of Wales Dock. An option was granted some time ago to a firm who have existing interests at Swansea, but whose chief operations at present lie in the North of England. If the negotiations succeed, a new dry dock will be constructed capable of docking the largest vessels afloat.

WE have received from Messrs. R. Martens & Company, Limited (development department), 149, Leadenhall Street, London, E.C.3, a copy of a publication entitled "Russia: A Journal of Anglo-Russian Trade" No. 8, Vol. I., deals with the historical development and future of Anglo-Russian trade; Russian law and the assignment of commercial and industrial undertakings; Russia's gold resources; and current news of Russian trade. The publication is issued at 6d. net.

THE Admiralty notify that they have appointed Denny, Mott and Dickson, Ltd., of 14, Fenchurch Street, London, E.C.3, as their agents for the reception and distribution of Admiralty stocks of timber for shipbuilding and ship repairing purposes. Shipbuilders and ship repairers are requested to apply to the Director of Materials and Priority, Admiralty, Great George Street, London, S.W.1, for any timber they may be requiring which they cannot obtain in the open market.

IT was announced at a meeting of the Tees Conservancy Commission at Middlesbrough recently that Lord Furness has completed the purchase of eighty-five acres of reclaimed land on the north bank of the Tees as a site for the extension of a shipbuilding yard, dry docks, and engineering works. The site has a river frontage of 2,590 ft., and under Lord Furness's scheme, facilities will be provided for launching vessels of heavy tonnage. The work of erection will be commenced at an early date.

IN view of the need for expediting the construction of new merchant ships, notice has been given to the Standard Shipbuilding and Engineering Company, Limited, that the Government desire to take over the yard at Chepstow. In addition to taking over the partially completed yard the Government scheme includes the construction on the opposite side of the river of a wet dock of considerable area with an entrance lock from the river, the intention being to use the wet dock as a fitting-out basin.

THE negotiations by the amalgamated firms of Steel, Peech & Tozer, Limited, of Ickles, and Samuel Fox & Company, Limited, of Stockbridge, with the Frodingham Iron & Steel Company, Limited, for a fusion of interests are now completed. One of the chief advantages of the amalgamation is that the Ickles and Stocksbridge works will be assured of a full supply of steel-making materials. The negotiations bring into the group a half-share of the Appleby Iron Company, Limited, Scunthorpe.

A THIRD electric steel furnace is at present in course of erection at the works of the National Steel Foundry (1914), Limited, at Leven, Fife, and is expected to be in operation at an early date. A 5,000 h.p. steam-turbo generating set has also just been installed to supply current for the steel-melting furnaces and other purposes. The machine shop connected with the works has been completely re-constructed, so that all castings can now be supplied either partly or wholly machined exactly to users' requirements. A special branch of the business is that devoted to the production of cast-steel wheels for heavy motor vehicles.

T. H. WATSON & COMPANY (of Sheffield), LIMITED, who control the patents of the Greaves-Etchells electric furnace, as already noted, have formed a company to handle the furnace business in the United States and Canada. The new company will be known as the Electric Furnace Construction Company, with offices in Philadelphia. Mr. F. Hodson, a director of the company, is now in the United States to arrange the details of the new company, and will act as its president. Mr. F. J. Ryan, of the Snyder Electric Furnace Company, will be the general manager. Messrs.

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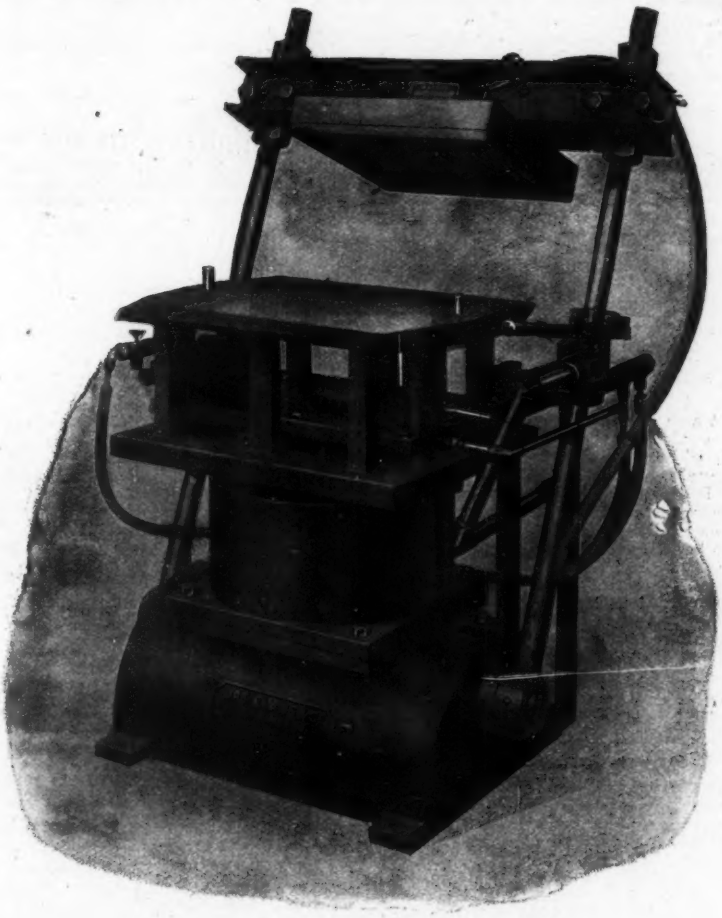

JAMES EVANS & CO., BRITANNIA WORKS,

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Watson have supplied one 6-ton furnace to the Singer Manufacturing Company and one to the National Radiator Company.

Charron, Limited, have occupied a controlling interest in W. S. Laycock, Limited. The company have invested the sum of £52,000 in acquiring the control of the business, and in exchange they are to receive £20,000 second debentures, to be created, and 75,500 ordinary shares out of a total of 100,000, thus giving the company complete control of the future working of the business. The total capitalisation of W. S. Laycock, Limited, is £50,000 five per cent. preference shares and £100,000 ordinary shares. There are also £60,000 in first debentures. It is a further part of the arrangement that the dividend on the preference shares shall be reduced from 5 per cent. to 3 per cent. for the next five years, and to 4 per cent. for the following five years.

In connection with the scheme to enlarge the scope of their operations, the directors of W. and T. Avery, Limited, notify the ordinary shareholders that applications will be received for £72,105 five and a half per cent. "B" preference and £72,105 ordinary £1 shares. The price is fixed at par. The terms of payment are convenient, instalments being spread over the remainder of the financial year which ends March 31. Shareholders must apply for an equal number of ordinary and preference shares, and the pro rata allotment works out at one new ordinary and one new preference share for every two ordinary shares now owned. The new ordinary shares will not participate in any interim dividend which may be declared, but at the close of the financial year will receive a return equal to one-third of that paid for the twelve months on the existing ordinary capital.

The members of the Chartered Institute of Secretaries were recently invited to record their views with regard to the adoption of a decimal system of coinage in the United Kingdom, and the substitution of the metric system for the existing United Kingdom weights and measures. Of the replies received 85 per cent. considered that a change to a decimal system of coinage would be favourable to the business in which they were engaged, whilst 66 per cent. favoured a £ basis of coinage in preference to the "Imperial-Crown" or dollar basis. In regard to weights and measures, 86 per cent. favoured a change to the metric system, 53 per cent. of whom already used that system in their business. The large majority were of opinion that the metric system not only facilitated their internal office work but had led to extended business relations with other countries, including France, the United States, Russia, and the Argentine. In 61 per cent. of the replies the business of the company was stated to be hindered by the use of the existing system of weights and measures.

An Order has been issued by the Ministry of Munitions prohibiting the manufacture of stainless steel for cutlery purposes. The wording of the Order is as follows:—"In view of the difficulties in getting supplies of ferro-chrome I am directed to inform you that from the above date the use of the same in connection with the manufacture of stainless steel for cutlery purposes is prohibited. Ferro-chrome must only be used in connection with high-speed, crucible carbon steel and alloy steel, and in the case of the latter only where a priority certificate or other permit number has been obtained which will warrant the manufacture of the steel in question." This steel was first introduced for table cutlery in the autumn of 1914, shear steel being previously in use for the best classes of table knives. The complaint of the manufacturers is that about 100 tons of ferro-chrome per annum would keep the trade together and also keep in the trade some of its most skilful craftsmen. If the trade is captured by other countries through this Order, an important branch of one of Sheffield's staple industries will be doomed.

Dissatisfaction is expressed by brassfounders with reference to a recent Order of the Ministry of Munitions respecting brass swarf. In pursuance of a resolution passed by the Masters' Association at Birmingham protesting against the Order, a deputation visited London last month, and interviewed officials of the Ministry of Munitions. The deputation consisted of Mr. J. W. Madeley (Chairman of the Birmingham Brass Masters' Association), Messrs. H. Bisseker, Hopkins, Sperryn, and Massey. The party was accompanied by Mr. George Gummer, of Rotherham (Chairman of the Northern Brassfounders' Association), and the secretary of the Birmingham Brass, Tube and Metal Association (Mr. Squires). The deputation was received by Sir Leonard Llewellyn, Lieut.-Colonel Carmichael, Mr. Sewell, and Mr. Danby, of the Materials Department of the Ministry of Munitions. Mr. Madeley reviewed the whole question, and called the attention of the representatives of the Ministry to the position in which manufacturers were placed. It was recognised by the Government officials that hardships would be inflicted upon certain manufacturers, and arrangements were made by which it is hoped a modification of the Order may be secured. With this end in view a conference was arranged to be held in Birmingham in the course of the next few days.

Applications for Patents.

The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.

Ashcroft, E. A. Manufacture of oxides, or salts, of tungsten, or of metallic tungsten from substances containing tungsten. 12,362. August 28.

Ashcroft, E. A. Manufacture of oxides, or salts of metals, or of metals, or non-metals, from ores, minerals, intermediate products, etc. 12,364. August 28.

Ashcroft, E. A. Manufacture of aluminium or its oxides or salts from materials containing aluminium. 12,365. August 28.

Ashcroft, E. A. Manufacture and use of silicon chloride and removal of silica from fused melts. 12,366. August 28.

Avery, W. & T. Scales for automatically weighing granular, etc., substances. 12,313. August 28.

Avery, W. & T. Hardness-testing machines. 12,453. August 30.

Bailey, W. Furnaces for melting steel, etc. 12,200. August 25.

Barraclough, W., and Crossley, J. Core-box making for valve patterns. 12,761. September 6.

Bone, D. R. Process of producing and conserving heat for furnaces, etc. 12,896. September 8. (United States, August 22, 1916.)

Cornthwaite, H., and Cornthwaite, S. Electric induction furnaces. 12,816. September 7.

Davis, W. Casting-machines. 12,368. August 28.

Dobson, J. Hardness-testing machines. 12,463. August 30.

Dowson & Mason Gas Plant Company, and Webb, F.A. Open-hearth gas-producers, etc. 13,049. September 12.

Eckford, W. Manufacturing moulded articles of lead, lead alloys, etc. 12,391. August 29.

Evans, P., and Mackintosh, R. D. Production of aluminium. 13,187. September 14.

Ferrier, E. Apparatus for recovery of metal alloys from by-products of foundries, etc. 13,156. September 13.

Freeman, N. H. Means for controlling temperature in furnaces, etc. 12,020. August 21.

Hall, I. Furnaces for melting steel, etc. 12,200. August 25.

Hall, I. Furnaces for melting metals, heating bars, etc. 12,201. August 25.

Harvey, L. C. Crucible melting-furnaces. 12,912. September 8.

Hill, P. W. Cupolas, blast furnaces, etc. 12,045. August 22.

Hodgson, L. S. Casting metal ingots, etc. 12,137. August 24.

Hosack, H. H. Moulds for metal ingots. 11,661. August 14.

Internal High-Speed Steel Company. Core-removing apparatus. 11,948. August 20. (United States, June 19.)

Jones, S. Vertical retorts for destructive distillation of coal, etc. 12,134. August 23. (Australia, July 15, 1916.)

Lake, W. B. Melting metals. 13,115. September 13.

Morgan Crucible Company. Crucible melting-furnaces. 12,912. September 8.

Morterud, J. A. Process for tempering and hardening copper. 12,265. August 27.

Myatt, W. J. Metal-casting moulds. 12,579. September 1.

Price, C. F. Crucible furnaces for melting brass, etc., for casting. 11,647. August 14.

Smith, A. A. Apparatus for recovery of metal alloys from by-products of foundries, etc. 13,155. September 13.

Stobie, V. Metallurgical furnaces. 12,088. August 23.

Turner, W. de C. Gas-producer. 13,041. September 11.

Wallwin, J. M. Furnaces. 12,646. September 4.

Welford, R. Production of aluminium. 11,865. August 18.

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Kentish Shipbuilding and Engineering Company, Limited.—Capital £20,000 in £1 shares.

C. E. Lyon, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers.

Tungsten Products, Limited.—Capital £25,000 in £1 shares. Registered office: Caxton House, S.W.

Smiths Highgate Brassfoundry, Limited.—Capital £2,000 in £1 shares. Registered office :—225, Mosley Road, Birmingham.

R. Lilly & Sons, Limited.—Capital £10,000 in £1 shares, brassfounders, carried on at 62, Barr Street, St. George's, Birmingham.

Richmond (Surrey) Foundry, Limited. — Capital £5,000 in £1 ordinary shares. Registered office: Lower Petersham Road, Richmond, Surrey.

Rotasphere Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 82, Belvedere Road, S.E.1.

John Cran & Somerville, Limited.—Capital £50,000 in £1 shares, to take over the business of John Cran & Company, shipbuilders, engineers, etc., Leith.

Stephen Cox & Son, Limited.—Capital £5,000 in £1 shares, to carry on the business of safe manufacturers. Registered office: Dudley Road, Sedgeley, Staffs.

Permanent Mesh Gear, Limited.—Capital £6,700 in £1 and 1s. shares, to acquire an interest in the Collier change-speed gear. Registered office: 116, Fore-Street, E.C.

Clements, Jeakes & Company, Limited.—Capital £25,000 in 3,000 5 per cent. cumulative pref. shares of £5 each and 10,000 ordinary shares of £1 each. 51, Great Russell Street, W.C.

Engineering Components, Limited.—Capital £7,500 in 5,000 ordinary shares, and 2,500 7 per cent. preference shares of £1. Registered office:—Reno Works. Royal Crescent, Wealdstone.

Stokes Castings, Limited.—Capital £6,000 in £1 shares, to adopt an agreement with F. W. Stokes, R. I. Ashley and A. M. Stokes. Registered office: Union Foundry, Mansfield, Notts.

Watson & McLean, Limited.—Capital £10,000 in £1 shares, to take over the business of engineers, crane and chain makers, etc., carried on as D. Watson & Company, Harmony Row, Govan.

G. F. Crighton, Limited.—Capital £2,000 in £1 shares, to take over the business of diesinkers, toolmakers, and stampers carried on by G. F. Crighton, as G. F. Crighton & Company, at 28, Spencer Street, Birmingham.

Kennish & Company, Limited.—Capital £2,000 in £1 shares, to take over the engineering business carried on by J. H. & W. J. Kennish, as Kennish & Company. Registered office: 17-21, Unwin Street, Cross Lane, Salford, Lancs.

R. C. Brinton & Company, Limited.—Capital £35,000 in £1 shares, to take over the business of an iron and steel merchant, etc., carried on by J. B. Field, at Birmingham, as R. C. Brinton & Co., and at Wednesbury as "Adams & Richards."

Edgehill, Limited.—Capital £40,000 in £1 shares, to carry on the business of ironmasters, etc. The first directors are Sir Gilbert H. Claughton, Bart., Mr. J. Tryon, and Mr. C. Tryon. Registered office: The Priory Offices, Dudley.

E. Gray & Son, Limited.—Capital £10,000 in £1 shares, to carry on the business of manufacturers of small tools. The first directors are J. Gray, A. E. Gray and E. J. Turner. Registered office: 18-30, Clerkenwell Road, E.C.

Successors to the Otto Coke-Oven Company, Limited.—Capital £100,000 in £1 shares, to acquire part of the undertaking of the Otto Coke Company, Limited. The first directors are J. A. Christie, E. D. Simon, W. Hawdon, and A. Stanley.

Reliance Engineering Company (Sheen), Limited.—Capital £1,000 in £1 shares. The first directors are A. Starley, A. T. Creser, H. J. Owens, and H. W. Carter. Registered office: 339a, Upper Richmond Road, East Sheen, Surrey.

Mersey Shipbuilding Company, Limited.—Capital £50,000 in £1 shares, to enter into an agreement with J. J. O'Neill. The first directors are J. J. O'Neill (permanent managing director) and J. Morgan. Registered office: 453, Strand, W.C.

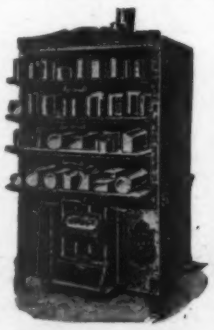
Uranium Steel Company, Limited.—Capital £3,000 in £1 shares, to acquire any inventions and rights relating to the smelting and refining of iron, etc. The first directors are A. Rollason and F. Perry. Registered office: 7, Station Road, Beeston, Notts.

Slack & Parr, Limited.—Capital £1,000 in £1 shares, to carry on the businesses of mechanical, electrical, and general engineers. The first directors are H. S. Slack, H. B. Parr, and D. J. Bedford. Registered offices Sideley Road, Kegworth, Leicestershire.

T. E. MANSERGH.

EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL AND
COAL DUST BLACKINGS
MANUFACTURED.

Wheathill Charcoal Works, SALFORD.



THE "PORTWAY"
PORTABLE CORE OVENS
For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

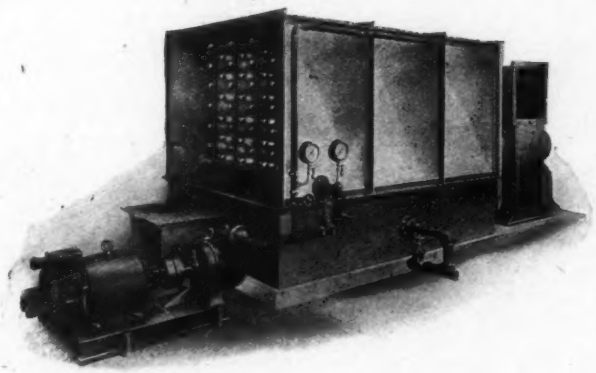
Will you please quote us your best price for four more like it,

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers: **C. PORTWAY & SON,** TORTOISE STOVE & PORTWAY PORTABLE OVEN WORKS, **HALSTEAD, ESSEX.**

TRADE SIROCCO MARK

Air Washers



CLEAN AIR
For
Air Compressors

These Washers ensure clean valves and cylinders and the elimination of grit troubles and their attendant expenses.

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DAVIDSON & CO., LD.
Sirocco Works,
:: BELFAST. ::

T. & I. BRADLEY & SONS, LTD.,
DARLASTON, South Staffs.
SPECIAL COLD BLAST PIG IRONS.

Brands:

R.A.M.	IXL. C.B.R.	D.M.R.
FOR CYLINDERS.	FOR CHILLED CASTINGS, &c.	CHARCOAL FOR MALLEABLE CASTINGS, &c.

✣ SELECTION ✣ ANALYSIS ✣ FRACTURE AND CHILL ✣ GUARANTEED ✣

ALL MINE.	WARM BLAST.	COLD BLAST.
◆ A M ◆	I X L.	I X L.-CB.

☛ IF YOU HAVE DIFFICULTIES WITH YOUR SPECIAL CASTINGS CONSULT US.
We can put you right.

Deaths.

Mr. H. E. Evered, of Evered & Company, Limited, brassfounders, Birmingham, died recently at the age of 38 years.

The death is reported of Second-Lieutentant J Furness, son of Mr. J. Furness, J.P., manager of the Straid Ironworks, Ballyclare, Ireland.

Mr. J. E. Storey, who had lately been engaged on Government work in London, and was formerly works manager to Petters, Limited, Yeovil, died recently.

The death took place at Neath last month of Colonel A. S. Gardner. The deceased gentleman was well known in the district, and was for many years connected with the Eagle's Bush Foundry.

The sudden death, at the early age of 52 years, is announced from New York of Mr. Henry Souther, one of the pioneers of the standards movement in connection with the American automobile industry.

The death has occurred, at his residence, at Alsager, near Stoke-on-Trent, in his 73rd year, of Mr. F. W. Llewellyn, who for a number of years was managing director of the Shelton Iron, Steel and Coal Company, Limited.

The death occurred recently of Mr. G. Salter, of George Salter & Company, Limited, ironfounders, etc., of West Bromwich, at the age of 61 years. The deceased had been associated with the firm during the whole of his business career.

Mr. P. G. B. Westmacott, of Rosemount, Ascot, and Benwell Hill, Newcastle, died last month in his 87th year. The deceased gentleman, who was a distinguished engineer, was for many years associated with the Elswick Works.

German papers report the recent death of Anthony Ritter von Kerpely, the Hungarian metallurgist of international fame, inventor of the gas-producer bearing his name, and up to three years ago general manager of the Austrian Alpinen-Montan Company.

Mr. Thomas Mitchell, sen., died at his residence, "Bessie Dell," Lostock Park, near Bolton, on the 16th ult. The late Mr. Mitchell was in the seventy-sixth year of his age and was, prior to a few years ago, senior partner in the firm of Thomas Mitchell & Sons, Limited, engineers' merchants, Bolton.

Sir Thomas B. Royden died last month in his 86th year. For a long period he was one of the foremost figures in the commercial and public life of Liverpool.

He was educated at Liverpool College and apprenticed to his father's firm, Messrs. T. Royden & Sons, shipbuilders and shipowners. Shortly after coming of age he was admitted a partner.

The death occurred suddenly last month of Mr. Thomas Henry Ash, of The Mount, Richmond Hill Road, Edgbaston. The eldest son of the late Mr. Joseph Ash, of Birmingham and Leamington, the deceased gentleman was chairman of Ash & Lacy, Limited, metal perforators, Meriden Street, and Great Bridge, a director of Ash Brothers, & Heaton, Limited, tinplate workers, Dartmouth Street, and a member of the firm of Messrs. Joseph Ash & Sons, tank manufacturers, Rae Street.

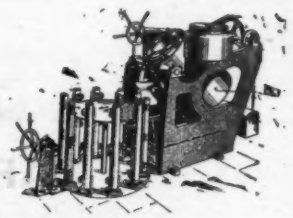
We much regret to announce the death, on September 12, at Westminster, Orange River Colony, South Africa, of Mr. Benjamin Wrightson Head, fourth and youngest son of the late Mr. Jeremiah Head and nephew of Sir Thos. Wrightson, Bart. Mr. Head had a successful career as a consulting engineer and expert in iron- and steel-making plant, and it is to be deplored that he should have died, at the early age of 42, just at a time when his firm is reaping the full reward of many years of patient and persistent efforts. On the death of Mr. A. P. Head in 1905 Mr. B. W. Head became sole partner, and in the same year formed and became managing director of Messrs. Wellman, Seaver & Head, Limited, now of King's House, Kingsway, London, W.C.

A Revelation to Steel Founders!

Monometer Steel Melting Furnaces

(Hall's Patents)

¶ Tilting and Pit Types.
¶ Installed by leading works in Sheffield.
¶ Oil-fired.
¶ Better Steel than any other system.
¶ Unskilled labour.
¶ Quicker melting.
¶ More economical and efficient than electric furnace.



MONOMETER MFG. CO., LTD., Engineers and Ironfounders,
Edited by I. H. HALL, Managing Director.
ASTON, BIRMINGHAM.

H. J. EVANS & CO. Telegrams: "Gunmetal." Telephone: Bank 3842.
25, Lord St., LIVERPOOL.

METALLURGISTS' MANUFACTURERS, and MINE OWNERS.

Speciality: FERRO-SILICON, ALL GRADES. FUEL OIL FOR DIESEL ENGINES.

The following is a list of some of our lines, prices below competitors'. It will pay you to send us your enquiries :—

FERRO-ALLOYS, MINERALS, METALS & CHEMICALS, RADIUM-BROMIDE. FERRO-CHROME. FERRO SILICON. FERRO-VANADIUM. FERRO TUNGSTEN, FERRO-MANGANESE, FERRO-MOLYBDENUM, FERRO-TITANIUM,

ALUMINIUM, CADMIUM, CARBONATE OF POTASH, SILICA, REFINED SULPHUR, FRENCH CHALK, ASBESTOS POWDER. **PLUMBAGO, GRAPHITE,** MANGANESE, LEAD ORE, FELSPAR,

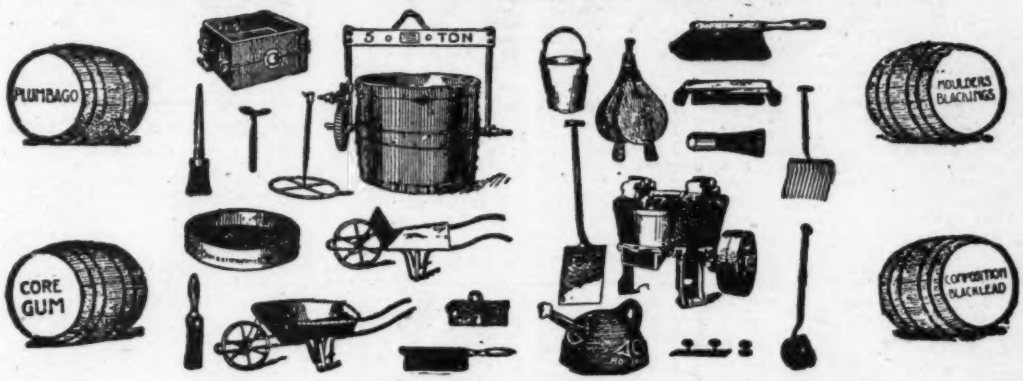
CALCINED MAGNESITE AND MAGNESITE BRICKS, FLUORSPAR, BOG ORE, BAUXITE, CHROME ORE, IRON ORE, SPENTOXIDE AND RETORT CARBON, OXIDES OF IRON, &c.

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



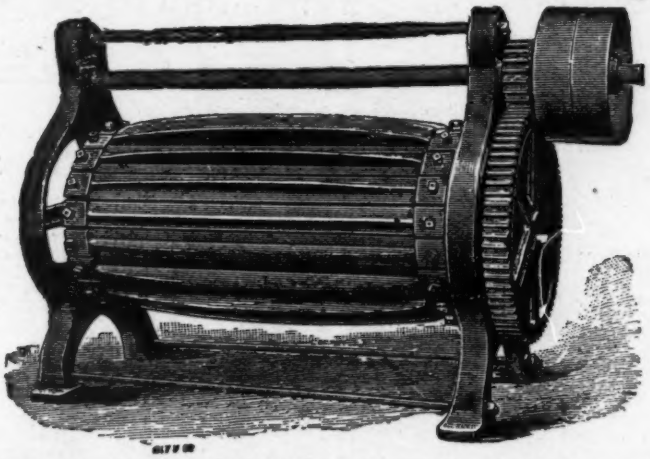
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself:—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

Pig-Iron.

	£ s. d.
West Coast hematite, mixed Nos. 1, 2 and 3	6 7 6
Special under 0.03 P. & S... ..	6 15 6
„ „ 0.02 „	7 0 0
East Coast hematite, mixed Nos. 1, 2 and 3	6 2 6
Special under 0.04 P. & S. ..	6 7 6
Special under 0.03 P & S. ..	6 15 6
„ „ 0.02 „	7 0 0
Scotch hematite, mixed Nos. 1, 2 and 3..	6 2 6
Special under 0.03 P. & S. ..	7 10 0
Welsh hematite, mixed Nos. 1, 2 and 3	6 2 6
Special under 0.03 P. & S. ..	6 15 6
„ „ 0.02 „	7 0 0
HEMATITE—MALLEABLE— Refined—	
Refined Cupola Cast	8 0 0
Refined Cupola Cast to guaranteed analysis..	8 5 0
Cast direct from Blast Furnaces—	
Small Pig-Iron, all grades ..	7 10 0
Medium Pig-Iron White to Grey mottled	7 5 0
Medium Pig-Iron, all other qualities	6 17 6
Large Pig-Iron, all grades ..	6 17 6
Lincolnshire, basic or foundry ..	4 12 6
Cleveland, No. 1	4 11 6
„ other grades	4 7 6
„ basic	4 17 6
Northamptonshire, forge	4 7 6
„ fdy numbers	89/0 94/0
„ basic	4 17 6
Derbyshire, forge	4 10 0
„ foundry numbers	92/6 96/6
Derby & Notts. basic.	4 17 6
Leicestershire & Notts., forge ..	4 10 0
„ „ foundry nos.	92/6 96/6
North Staffs, forge	4 15 0
„ „ foundry	4 17 6
„ „ basic	4 17 6
South Staffordshire—	
Part mine forge	4 15 0
„ foundry	4 17 6
Common Staffordshire ..	4 10 0
All mine forge	5 15 0
„ foundry	6 0 0
Warm air forge	7 5 0
„ foundry	7 15 0
Lord Dudley's silicon	8 7 6
Cold blast	9 2 6
Basic	4 17 6
Scotch foundry and forge—	
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. ..	5 14 0
Nos. 3, 4, and lower grades of all other brands	5 15 6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1½%

In all districts 1s. extra may be charged for Basic cast in chills.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 3s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings	5d.
Bar Ends	6d.

Both per lb. net delivered steel makers' works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£ s. d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton	—
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	—
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton	—
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton	—
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	—
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	—
Ferro-titanium: 23/25%, per lb. carbonless..	—
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained ..	—
Ferro-phosphorus: 20/25%. Per ton	—
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained	—
*Ferro-manganese 80%	25 0 0
„ export £36 0 0	—39 0 0

* F.o.b. Liverpool.

Non-Ferrous Metals.

Copper.

	£	s	d.	£	s.	d.
Standard, Cash	..110	0	0	110	10	0
Three months	..110	0	0	110	10	0
Electrolytic ..	..125	0	0	121	0	0
Tough ..	..123	0	0	119	0	0
Best selected ..	..123	0	0	115	0	0

Tin.

Standard, Cash	..245	10	0	245	15	0
„ Three months	242	15	0	243	0	0
English Ingots ..				242	10	0
Bars	—			—		
Refined	—			—		

Spelter.

American ..	.. 54	0	0	50	0	0
Specials.. ..	..	—		—		
Hard	..	—		45	0	0
British ..	.. 56	10		57	0	0

Lead.

Soft Foreign ..	.. 30	10	0	29	10	0
English	..	—		Nom.		

Antimony.

Regulus ..	..	—		85	0	0

Aluminium.

Virgin Metal 98/99% per ton	—

Phosphor Bronze.

	Per ton.
INGOTS.	
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots.. ..	—
CASTINGS.	Per lb.
I. or II.	—
III. IV. or V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid ..	—
„ Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. 35/- above price of best selected copper.

15 per cent. Phosphor Copper .. 40/- above price B.S

Phosphor Tin (5 per cent.) .. £23 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM)

***Chromium (Metallic).**

98/99% purity, per lb.	—

***Nickel.**

In cubes, 98/99% purity Per ton	—

Nickel Silver.

	per lb.
Ingots for raising	—
Ingots for Spoons and Forks ..	—
„ rolled to spoon size ..	—

***Tungsten Metal Powder.**

98/98% purity.. per lb. ..	—

***Molybdenum Metal.**

96/98% purity.. per lb. ..	—

***Cobalt Metal.**

97% purity .. per lb. ..	—

Quicksilver.

75 lb. bottle	—

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d.	s. d.
Steel scrap, heavy melting..	105 0	—
Iron scrap cast (cupola metal)	90 0	95 0

London (f.o.b.).

Heavy steel		110 0
Light „		55 0
Heavy cast		95 0

Control Prices.

Heavy Steel Melting Scrap	105 0	125 0
Steel Turnings and Borings ..		70 0
Steel Turnings and Borings mixed with Wrought Iron, &c. ..		50 0
Steel Scrap, all other Classes ..		105 0
Wrought Iron Scrap ..	105 0	125 0

Per ton delivered Buyers' Works.

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £ s. d.
Hy. Electrolytic Copper Scrap ..	—
Hy. Selected Scrap Brass ..	—
Hy. Tinned Copper Wire	—
Best Selected Gunmetal Scrap ..	—
Re-melted Ingot Lead	—

Stocks.

Metals.	Tons.
Copper, Europe and afloat	—
Tin London, Holland, U.S.A. and afloat	19,575

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	32 0	—
Foundry	42 6	—

Glasgow.

Foundry Coke	—	42 0
Furnace Coke	30 0	—
Gas Coke	—	

London.

Welsh or Durham Foundry, d/d London Stations in truck	45 6	53 0
Ditto, d/d Birmingham Stations	44 0	48 0
Yorkshire, d/d London Stations, in truck	42 6	—
Ditto, d/d Birmingham Stations	39 6	—

CONTROL PRICES OF COKE.

	s d.
Durham and Northumberland blast furnace	28 0
„ foundry	30 6
South Yorkshire, West Yorkshire, Lancashire, Staffordshire and Midland Counties blast furnace	25 8
South Wales blast furnace ..	30 0
„ foundry	43 0

All per ton net. f.o.t. ovens.

SITUATIONS VACANT AND WANTED.

FOUNDRY and WORKS MANAGER, at liberty, desires appointment; wide experience light castings trade. Must be Government work. Good organiser; first-class references.—Address, Box 908, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOREMAN for Foundry, practical man, used to loam and other castings; good disciplinarian; Government work.—MONOMETER MANUFACTURING Co., Whitehouse Street, Aston; or Albion Foundry, Browning Street, Ladywood.

PATTERN MAKER WANTED, Brass; Aluminium Foundry, London; war work only. Good opportunity for really competent man.—Write, giving age, experience and salary required, to T. G., 18, Cornhill, London, E.C 3.

FOUNDRY MANAGER of large experience in modern methods of rapid production of iron and brass castings, together with a thorough knowledge of pattern-making in all its branches, seeks a new position.—Particulars, etc., Box 904, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

ABSTAINER, 28, good general experience in moulding, including plate — Member B.F.A. — would like position of trust.—Address Box 890, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

WANTED, FOREMAN for large Aluminium Foundry on motor and aircraft castings. Government work. Must be thoroughly experienced organiser, familiar with modern machine moulding. American experience desirable. Good salary and commission to right man. Permanency. — Apply to your nearest Employment Exchange, stating age, salary required and full details as to qualifications, quoting No. A.3718. No one on Government work need apply.

FOUNDRY FOREMAN desires change. Age 37; progressive. Expert in plate pattern work and moulding machines—hand, hydraulic or pneumatic. Can handle men with tact and get best results Drysand and Greensand. Well up in piece work, and can mix to analysis. Specialist in wheels and pulleys.—Reply Box 902, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOR SALE AND WANTED.

SMALL Foundry Business FOR SALE through death of owner.—Address Box 906, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

WAX CORE VENTS.—Large quantity for disposal ¼ and ½ inch. Price 1/3 per lb. delivered.—H. G. HILLS, 50, Fountain Street, Manchester.

PATENT No. 108,426, of 1916, relates to a drop flask Moulding Machine, whereby the system of moulding is rapid, accurate and inexpensive. Sale or licence.—TURNER, 28, Plumper's Road, Sheffield.

FOR SALE, Ground Ganister for Furnaces, Steel Works, etc.; also Lump Silica Rock, Fire Bricks, Silica Sand and Cement, of the finest heat-resisting qualities. Guaranteed supplies during winter months.—Apply, THE NORTH BRITISH REFRACTORY Co., Head Office, Vicar Lane, Sheffield.

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DEPARTMENT OF CHEMISTRY & METALLURGY.

Head of Department:
J. B. COLEMAN, A.R.C.S., F.I.C., F.C.S.

Lecturer in Metallurgy:
W. A. NAISH, A.R.S.M., A.I.M.M.

METALLURGY.

Day and Evening Courses commence September 24th, 1917. Pyrometry and Metal Analysis, Engineering Metallurgy, Metallography. The work is suited to the requirements of Metallurgists, Assayers. Special facilities are arranged for individual work in any other branch of Metallurgy, such as Assaying, Mechanical Testing and Research.

For fees and further particulars, apply to the Secretary (Room 65). *Telephone* 899 *Western.*

F. L. HUNT & CO.,
FOUNDRY
FURNISHERS
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FOUNDRY REQUISITES
Of every description.
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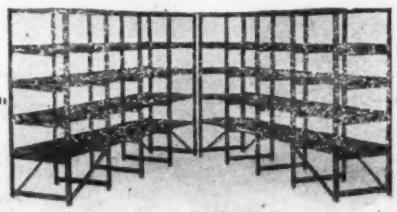

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Fireproof Steel Storage Bins
For Workshop and Warehouse
Write for Details.
Joseph Sankey & Sons, Ltd.,
Hadley Castle Works, WELLINGTON, Shropshire.

PLUMBAGO—CRUCIBLES.

Parting Powder.

WILLIAM OLSEN, LTD.,
Cogan Street, HULL.

FOUNDRY MATERIALS AND REQUISITES.

Largest Stock of Straw and Wood Fibre CORE ROPINGS.

Wax Core Vent.

GLUTRIN—CORE GUM.

FIRE BRICKS & CLAY
CUPOLA BRICKS.
Best Quality.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,
(STOURBRIDGE) Ltd.,
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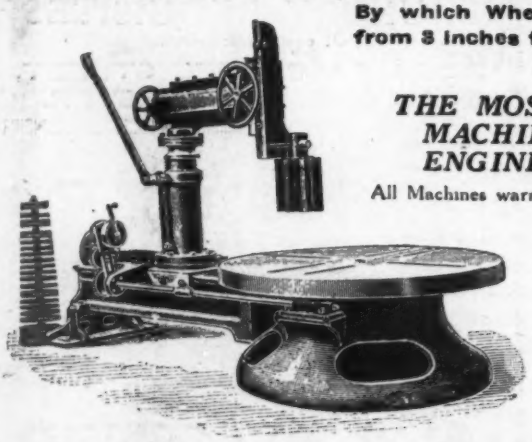

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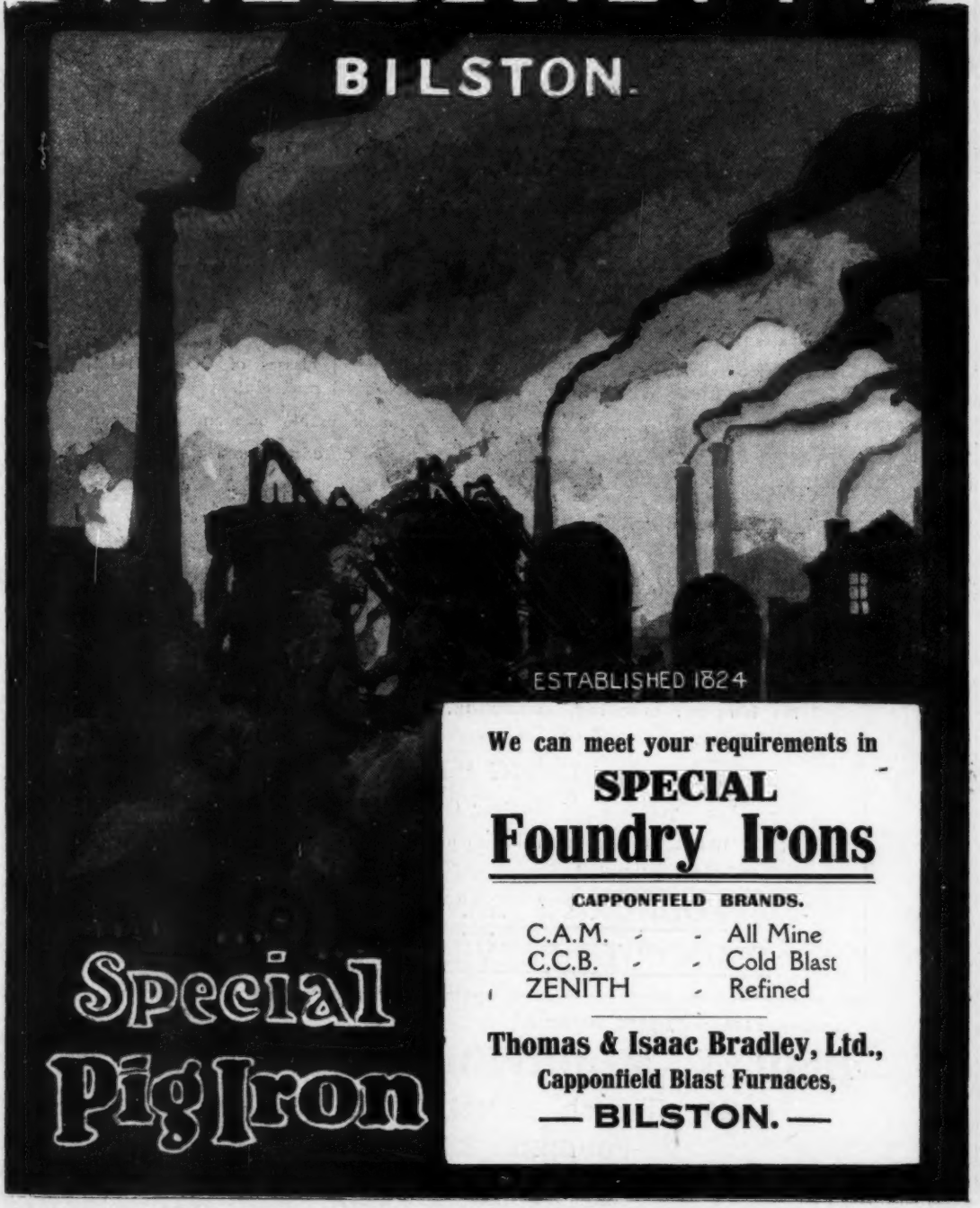

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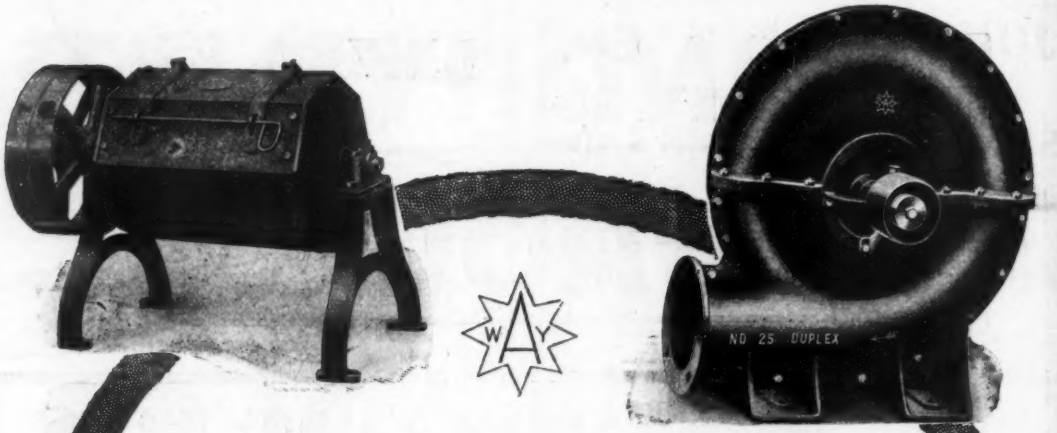

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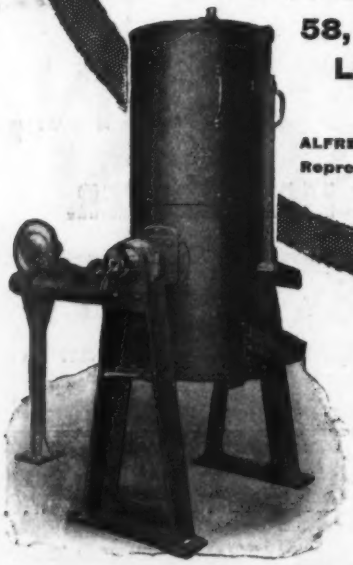

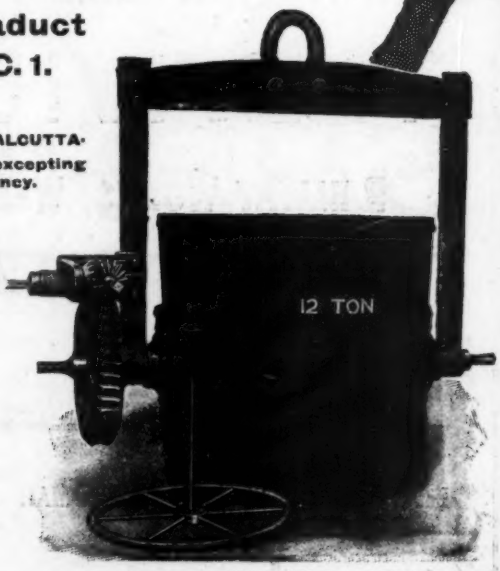

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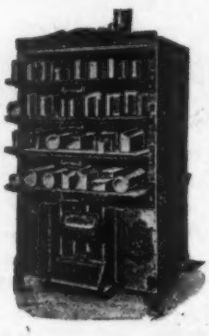

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PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

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Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it,

Yours faithfully,
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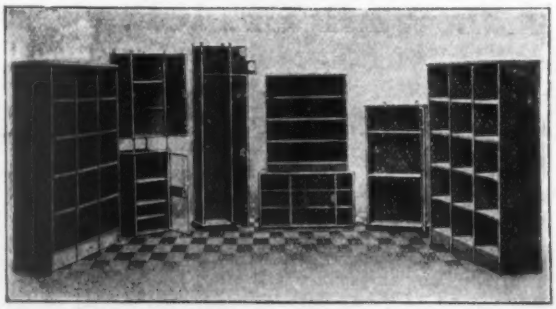

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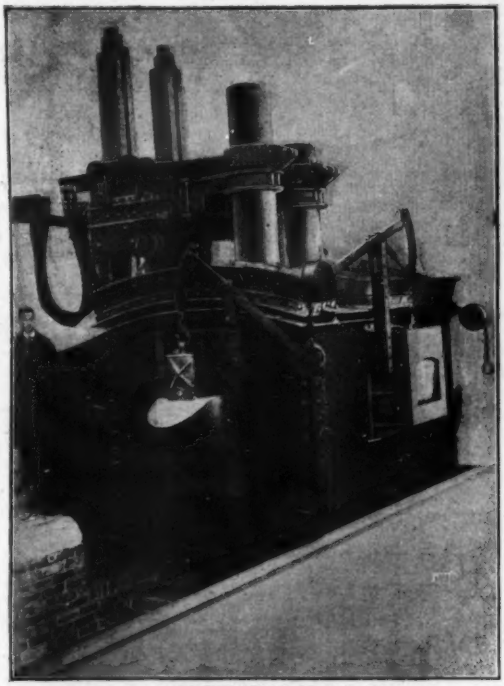

3-Ton GREAVES-ETCHELLS Electric Furnace.

FOR

STEEL CASTINGS

The Electric Furnace clearly leads—phosphorous and sulphur can be removed far more completely than by any other process. At the same time, the gases which molten steel generally holds in solution are largely eliminated, and a steel is produced of exceptionally high purity. The ease with which electric furnace steel, containing low carbon and only small amounts of silicon and manganese, can be poured into small and intricate castings, flowing smoothly like milk, setting perfectly quietly in the sink heads, and producing castings with hardly a trace of blow holes, even in the hands of comparatively inexperienced steel makers, is largely due to its great purity.

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ELECTRIC FURNACE

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Sizes—10 cwts. to 12½ tons.

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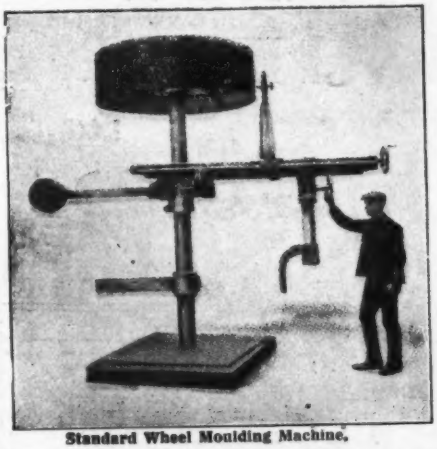

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No Loose Parts Liable to be Lost.

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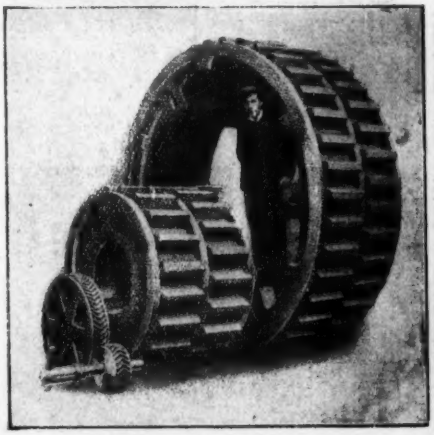
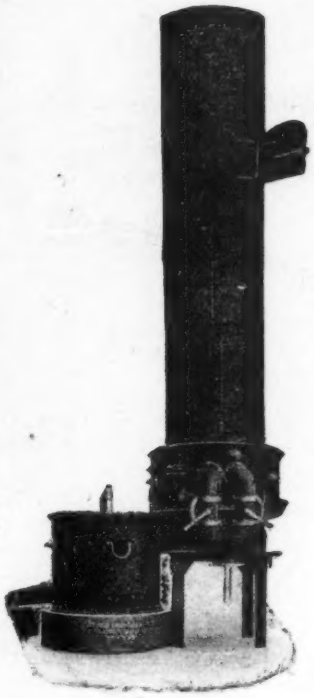


Wheels Moulded by this Machine.

FOUNDRY PLANT.



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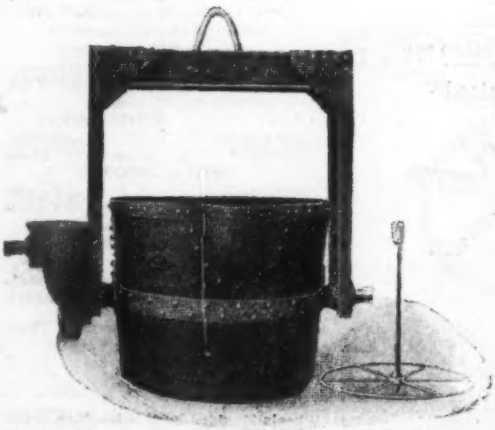

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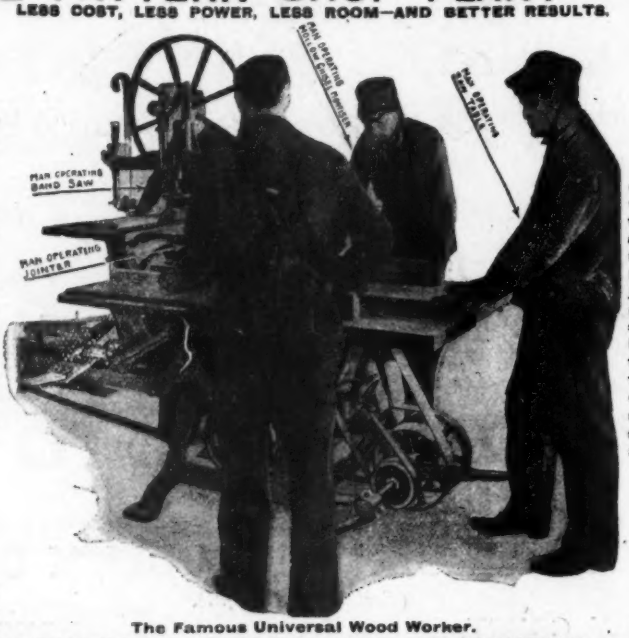

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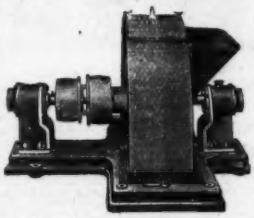

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